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ABSTRACTS OF SEDIMENT SURVEY PUBLICATIONS TO 1990

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Canada

SEDIMENT SURVEY SECTION

ABSTRACTS OF
SEDIMENT SURVEY PUBLICATIONS
TO 1990

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ABSTRACT

This document presents a compilation of abstracts from publications of the Sediment Survey Section of the Water Survey of Canada Division, Water Resources Branch, from its inception in 1961 until 1990. Publications are listed by author, subject, and province/territory; the abstracts are provided in alphabetical order by author.

RÉSUMÉ

Le présent document fournit une compilation de résumés des publications réalisées par la Section de l'étude des sédiments de la Division des relevés hydrologiques du Canada, Direction des ressources en eau, depuis sa création en 1961 jusqu'en 1990. Les publications sont classées par auteur et sujet suivis de la province ou du territoire; les résumés figurent par ordre alphabétique selon l'auteur.

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INTRODUCTION

The Sediment Survey Section of the Water Resources Branch, Environment Canada, is responsible for the collection of fluvial sediment data throughout Canada in cooperation with the Provinces.

This document is a collection of the abstracts of reports produced by or for the Sediment Survey Section since its inception to date. This covers the period from 1961 to 1990. For historical interest, a report dating to 1958 also is included--"An Initial Sedimentation Survey Programme for Canada" by the Water Resources Branch of the Department of Northern Affairs and National Resources. The abstracts include publications by the Section, articles in scientific journals by Headquarters staff, publications written by Regional staff but published by Headquarters, and work produced by others under contract to the Section.

There are four main parts to this document:

- a list of publications by author;
- the abstracts of each report, listed by author;
- a list of publications by subject;
- a list of publications by province/territory.

The abstracts, taken from the reports, comprise the bulk of the document. If an abstract was not included in a report, the report was summarized. In the case of publications with multiple government authors only one is given. For example, the report entitled "Sediment Investigations and Network Planning in Alberta" was prepared by the Sediment Survey Section in Ottawa, the Calgary District Office of the Water Survey of Canada, and the Alberta Department of the Environment. For brevity, it is listed here under "Sediment Survey Section" only. In the case of multiple individual authors, standard referencing has been used and all authors are listed. Whenever possible, abstracts are given in both English and French.

The documents contained herein reflect the numerous organizational changes which the sediment program has undergone over the decades, as part of the Inland Waters Branch, the Water Resources Branch, the Inland Waters Directorate, etc. A continuous sediment survey program was initiated in 1961 in Ottawa by the Water Resources Branch of the Department of Northern Affairs and National Resources. As examples, over the years the Section has been part of: the Department of Northern Affairs and National Resources; the Department of Energy, Mines and Resources; the Department of Fisheries and Forestry; Fisheries and Environment Canada; and Environment Canada.

However, while the management structure has evolved considerably over the years, the purpose of the Section has not--the collection of data, interpretation of these data, and production of information relating to sediment for the benefit of Canadians.

Information on requests for publications is found at the end of the document.

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ABSTRACTS BY AUTHOR

ACRES WESTERN LIMITED

River Bed Simulation Flume Feasibility Study, 40 p., 1970.

SUMMARY

Acres Western Limited was appointed by the Inland Waters Branch of the Federal Department of Energy, Mines and Resources to make a study of the feasibility of building a flume to simulated the river bed movement of relatively steep, coarsely-bedded streams. The work included the selection of the most suitable site, preliminary design, scheduling, and estimation of capital and operating costs.

It was found that there were no major engineering problems involved in the construction of the proposed facility and it was considered to be technically feasible. Of 15 sites studied, the most suitable site was determined to be the Western Irrigation District canal, near Calgary, Alberta. Measurements for the flume were 170 feet long and 10 feed wide, using a maximum flow of 350 cfs and a maximum water depth of 3.3 feet. Gravel handling facilities could continuously supply and recirculate gravel between the sizes of three inches and two millimetres, at a rate of six tons per minute. The flume would have a fixed concrete bed at a slope of 0.02, with slope changes possible by the placement of gravel in the flume bed. The proposed facility would take approximately 14 months for design and construction. The estimated capital cost of the facility was $767,000, with operating cost of $27,000 annually.

ADAMOWSKI, K.

Investigation and Utilisation of Long Term Suspended Sediment Records, 48 p., 1983.

SUMMARY

In recent years many problems related to understanding and of estimating sediment yield have become increasingly important. The problems of siltation, erosion, and environmental issues require reliable sediment information for decision making.

Unfortunately, the existing records are rather short, and can be grossly in error. Therefore, much effort now is being expended to examine various aspects of estimating the sediment load. The questions of accuracy and precision, short and long-term variation estimates, information content, etc. are being asked and investigated.

Since the sediment data exhibit such tremendous variability, it is then necessary to use probability and statistics to describe such a variability. This report presents a review of literature dealing with estimating sediment load with emphasis on the application of statistics.

The literature reveals that the sediment data have a skewed distribution, with the log-normal distribution being the most commonly reported. Also, the data show time persistence (autocorrelation). Consequently, skewness of the data should be reflected in estimating parameters of central tendency (i.e. mean vs median). The autocorrelation property of the data influences the sample size required to obtain an estimate of mean sediment load with a preselected confidence (usually a longer sample size is required). Furthermore, the information content of the data decreases with time dependent data.

The available continuous sediment records are relatively short (15-20 years at best) and the errors in estimating sediment loads are very large (perhaps as high as -80% to +900%). Thus the estimation of short and long-term variability of the dat is, at the best, very difficult. The long-term sediment yield can be estimated from a relationship with other parameters like surface waters, climate, and land use. Such studies are questionable due to the difficulties of establishing climatic trends (usually assumption of stationarity is made), and estimating such a relationship based on short sediment records.

As a first step in investigating the variability of the existing data, it would be very useful to undertake a study in order to determine what distribution(s) fits the sediment data best. Then, a basic analysis can be performed to study the required sample size, the information content, and accuracy and precision of estimating sediment load. Such studies would be relatively easy to perform, since many standard statistical packages can be used with appropriate modifications.

With the existing data base, although relatively short, it might be worthwhile to apply some more sophisticated statistical-stochastic techniques in order to estimate several important properties of observed sequences. In particular, a time series analysis, a well documented technique, could be applied to sediment records in order to investigate more closely the seasonality, time dependence

structure, trends, and stationarity conditions.

Such analysis could be extended to examine the watershed as a system. Such models would reveal perhaps more specifically the physical nature of the problem and account for uncertainty in the data, parameters and the model itself. Furthermore, extensions could be made to include regional information, which would have implications for network design.

ADAMOWSKI, K.
Statistical Analysis of Sediment Data Records, 100 p., 1984.

SUMMARY

The purpose of this report is to provide and discuss several statistical analyses of sediment data. Time series analysis, frequency analysis, and information content were investigated on three series of daily concentrations of different lengths.

The time series analysis of the monthly means revealed much periodicities in the sediment concentrations, especially for the two stations from Alberta where it accounted for seventy-seven and ninety-one percent of the variance of the series. Similarly, there were high periodicities in the daily data. There was no indication of trends in any of the three available series.

With daily sediment concentrations, their monthly means, as well as their annual means when possible, distributions were fitted to the three records. The usual distributions could not fit the daily data and the lognormal fitted the monthly means of the station from New Brunswick. The normal distribution fitted the annual means of that same record, while the lognormal will likely fit the other two, which are from Alberta. These two stations from Alberta were much more skewed than that from New Brunswick.

The variation of the information content throughout the year as well as the sample lengths required for a given degree of accuracy were determined. The monthly relative information content indicated that at the two stations from Alberta, because of the large seasonal variations in sediment concentrations, sampling could be reduced or even discontinued at certain times of the year, usually corresponding to winter months.

Because the annual means of these two highly skewed stations will likely be lognormally distributed, to which will correspond a high coefficient of variation, the required sample lengths for a ten percent accuracy in the mean with ninety-five percent confidence are enormous. Similarly, for the median, the sample lengths are also very large. At the New Brunswick station, however, only nine additional years of sampling are required to reach a ten percent accuracy in the mean with ninety-five percent confidence.

ADAMOWSKI, K., DAY, T., DALEZIOS, N.R., and GINGRAS, D.
"Information Content and Sample Length in Sediment Records", Integrated Design of Hydrological Networks, Proceedings of the Budapest Symposium, July 1986, IAHS Publ. no. 158, p. 133-140, 1986.

ABSTRACT

Sediment-concentration data were analyzed for trend, seasonality, probability, distribution, and information content. It was found that the analyzed data were trend-free, log-normally distributed, and showed strong periodicity. Information content varied throughout the year, suggesting that observations can be discontinued at certain times of the year. Sample lengths must be very long if it is necessary to have 10% accuracy in the estimation of the mean and median with 95% confidence.

ASHMORE, P.E.
Analysis and Interpretation of Assiniboine River Sediment Station Data, 193 p., 1990.

ABSTRACT

The Water Resources Branch (WRB), Environment Canada has operated six sediment stations on the Assiniboine River, Manitoba. These are, in downstream order, Kamsack, Russell, Holland, Rossendale, Portage la Prairie and Headingley. Programs were initially begun in 1956 by the Prairie Farm Rehabilitation Administration (PFRA) and taken over by WRB in the early 1960s. The longest running station is at Headingley, near the confluence with the Red River. Most of the rest of the stations were established in the late 1960s to monitor the effects of the Lake of the Prairies and Portage Diversion on sediment regimes in the river. Generally these stations ran for 6 to 10 years in the 1970s. The stations near Holland and at Headingley are the only ones currently active.

Review of the sediment data for each station shows that in all cases, except Rossendale, the period of sediment data cover the range of discharges successfully. The flow and sediment regimes at all the stations are affected by flow regulation to some extent. This is especially true near Russell, Portage la Prairie and Headingley where flow regulation has reduced spring flood discharges to a fraction of their natural magnitude and enhanced low flows in fall and winter. At the same time the peak sediment concentrations have also been reduced at Portage and Headingley. In several cases the peak concentration and discharge no longer coincide.

Average sediment concentration and load increase downstream along the river. This is particularly noticeable between Russell and Holland. Downstream of Holland the changes are relatively small, even prior to opening of the Portage Diversion. Similarly, mean annual loads increase dramatically between Russell and Holland (from 20 000 Mg to 500 000 Mg) before levelling off in the downstream part of the basin. The Portage Diversion removes, on average, 27% of the mean annual load of the river (measured near Holland), compared with 16% of the mean annual discharge. Combined with sedimentation at Portage Reservoir, this explains the decrease in average concentration at Portage and Headingley. Currently, standard errors of the estimate of the mean annual load are typically 20-30% and require considerably longer periods of record to reduce them substantially.

Mean annual sediment yields are difficult to assess accurately but the general pattern is that the upper basin has very low yields (< 3 Mg km^{-2} yr^{-1}), the central part of the basin relatively high yields (16 Mg km^{-2} yr^{-1}) and the lower basin (prior to the Portage Diversion) relatively low yields. In fact, if the load at Holland is subtracted, the lower basin has negligible sediment yield.

Soil erosion risk maps suggest that the contribution of fluvial sediment from much of the basin is probably minor. Similarly, the contribution of suspended sediment load from tributary streams is low, or appears likely to be low from their discharge and geomorphic character. On the other hand, there is great potential for sediment supply from riparian sources where the Assiniboine is incised into the silty sand of the Assiniboine Delta, between Brandon and Portage la Prairie. This probably the major source of sediment to the present river.

The present sediment data network provides an excellent record of the sediment regime of the Assiniboine River. Some additional useful information on sediment sources could be obtained from network adjustments, particularly a sediment station at Brandon and miscellaneous stations on some of the larger tributaries. There is no compelling reason to maintain operation of the currently active stations at Headingley and near Holland, although if a station were added at Brandon it would be useful to maintain operation of the Holland station for comparison.

RÉSUMÉ

Aussi disponible en français.

ASHMORE, P.E.

Sediment Station Analysis: North Saskatchewan River at Prince Albert - 05GG001, 49 p., 1987.

ABSTRACT

The Water Survey of Canada has operated a sediment station at Prince Albert (05GG001) since 1962. Until 1979 the data were collected year-round but since then the program has run between April and October only. Data are collected at a stable cross section in which the bed material is predominantly sand with gravel present on some small unstable bars.

Mean annual suspended sediment load is 3.09 x 10 t for the period 1963-1979 when annual flows were slightly above average. Annual flow and load declined through the late 1970s and early 1980s. Much of the annual load is transported during peak flows in April and July. The operation of Bighorn Dam since 1972 appears to have altered the flow and load regime such that April is now the dominant month instead of July. However, seasonal operation since 1978 has limited the amount of data available with which to assess this effect.

The existing particle size data are more than adequate to characterize the size distribution of the suspended sediment. The dominance of washload and possibly the homogeneity of the sediment sources result in the lack of an obvious trend in particle size with discharge. Point integrated sampling reveals the presence of some substantial variation in concentration across the channel, notably in the sand fraction.

While the existing data are generally adequate for regime characterization, it is recommended that an effort be made to better characterize the sediment regime since construction of the Bighorn Dam. In addition, establishment of seasonal stations in the basin upstream of Prince Albert may be necessary if major flow regulation projects are planned and also to provide background information on the major sources and fate of sediment in the basin.

RÉSUMÉ

Aussi disponible en français.

ASHMORE, P.E.
Suspended Sediment Transport in the Saskatchewan River Basin 204 p., 1986.

ABSTRACT

Compilation and analysis of suspended data from Water Survey of Canada sediment stations in the Saskatchewan River basin shows that sediment yield are highest in the Alberta Plains portion of the basin and are particularly high along sections of the Oldman River and Red Deer River (greater than 100 t $km^{-2}a^{-1}$). The Mountain and Foothills basins generally have yields of between 10 and 40 t $km^{-2}a^{-1}$. This produces the unusual tendency for yield to increase, rather than decrease, downstream along the main rivers. The ratio of annual load to annual flow follows a very similar pattern. Frequency distributions of daily yield and concentration show that the large Prairie streams have higher median values than the Eastern Slopes basins but that the latter have more strongly skewed distributions and peak values quite close to those of the Prairie rivers. The basins with entirely Prairie runoff sources also have strongly skewed distributions of daily concentration and yield. Comparison of data between stations is complicated by differences in the period and length of the sediment record.

The greatest amount of information, from a total of 112 sediment stations is derived from 23 "seasonal/continuous" stations with over 4 years of record. By comparison the "miscellaneous" stations provide very little information apart from long-term load estimates whose accuracy is difficult to verify.

Monthly mean load follows an annual pattern of variation very similar to that of discharge. Close to the Mountains there is a single peak in May or June, while in the large Prairie rivers two peaks often occur associated with spring runoff on the plains and later mountain snowmelt. Clockwise seasonal hysteresis in concentration is common, but some complications arise under regulation by upstream reservoirs.

The small Eastern Slopes basins tend to have larger proportions of their total load transported by extreme events larger than the mean annual flood and to have a great proportion of their annual load transported in fewer days than the large Prairie basins. In most cases, the "effective" discharge for the Eastern Slopes basins has a lower frequency of exceedance than that of the Prairie basins.

There is a tendency for the average particle size of the suspended sediment load to decrease downstream along the main rivers as greater proportions of silt and clay are added to the load. However, large sediment traps, such as Lake Diefenbaker, now interfere with this pattern. It is difficult to discern any systematic relationship between particle size and stream discharge, especially in the large Prairie rivers and the collection of data primarily during spring and early summer precludes analysis of trends through the year in particle size.

Review of data from other major drainage basins is recommended along with assessment of the miscellaneous data program and the particle-size analysis program. Future main-stem network changes should concentrate on the North Saskatchewan River. The impact of impoundment on the Cumberland Delta and on the Red Deer River downstream of Dickson Dam should be investigated. Future research should be aimed at sediment routing from the land through the stream network in basins of various drainage areas. This information can be used in tracing sediment-associated pollutants and in refining predictive models of suspended sediment yield.

ASHMORE, P.E. and DAY, T.J.
"Effective Discharge for Suspended Sediment Transport in Streams of the Saskatchewan River Basin", Water Resources Research, Vol. 24, No. 6, p. 864-870, 1988.

ABSTRACT

Effective discharge histograms for suspended sediment load were computed for 21 sites in the Saskatchewan River basin at which sediment records range from 5 to 29 years in length. The drainage areas fore these streams range from 10 to over 300 000 km^2. The effective discharge histograms have a variety of forms ranging from the classic unimodal form in which the peak occurs at discharges with a duration of 1 to 3% to those in which the effective discharge is the extreme event of record and including cases in which a single effective discharge is difficult to define. The percentage duration of the effective discharge ranges from less than 0.1% to over 15%; a greater range than previously has been reported. There is an obvious tendency for the percentage duration of the effective discharge to increase with drainage area and hence downstream through the drainage system.

ASHMORE, P.E. and DAY, T.J.
"Spatial and Temporal Patterns of Suspended Sediment Yield in the Saskatchewan River Basin", Canadian Journal of Earth Sciences, Vol. 25, No. 9, p. 1450-1463, 1988.

ABSTRACT

Long-term suspended sediment concentration and load records are available for 23 Water Survey of Canada sediment monitoring stations in the Saskatchewan River basin with drainage areas ranging from 10 km^2 to over 300 000 km^2. Mean annual sediment yield is greatest in the western Alberta Plains along the Oldman and Red Deer Rivers (over 100 tonnes km^{-2} $years^{-1}$) and tends to increase downstream along the main rivers until major reservoirs in Saskatchewan intervene. Average sediment concentration shows a similar pattern of variation to that of yield. Temporal aspects of suspended sediment transport vary along the drainage network. The range and skewness of the yield and concentration duration curves are greater in the intermediate size basins close to the Rocky Mountains and in two small basins with Prairie sources than they are in the large Prairie streams with Mountain sources and the glacier-fed upper North Saskatchewan River. Similarly, infrequent flows transport a larger proportion of the annual load in the smaller Foothills and western Plains basins than in the large Prairie streams because of differences in drainage area and discharge regime.

ASHMORE, P.E., YUZYK, T.R., and HERRINGTON, R.
"Bed Material Sampling Error in Sand Bed Rivers", Water Resources Research, Vol. 25, No. 10, p. 2195-2203, October 1989.

ABSTRACT

A total of 468 bed material samples were collected at cross sections of the sand bed of the South Saskatchewan River at Saskatoon to assess the random and systematic errors in the results from four commonly used samplers. Statistically significant difference in particle size distribution occur between the results obtained from different samplers at the same location, in part due to variability in retention of the small particles. The differences are greatest in silty sand and least in well-sorted, medium sand. the precision of results from repetitive samples at the same location using the same sampler depends on both the sampler and the composition of the bed material. Except in well-sorted medium sand, a single sample at a vertical is inadequate to determine the particle size of a given size fraction to within 10% with a probability error of 0.1. In some cases 10 or more samples may be required. The magnitude of these statistical errors at a given location is generally less than the within-reach variability in bed material particle size, and therefore the appropriate choice of sample location is critical.

ASHMORE, P.E., YUZYK, T.R., and HERRINGTON, R.
Bed-Material Sampling in Sand-Bed Streams, 47 p., 1988.

ABSTRACT

A variety of bed-material samplers have been designed for sand-bed streams. There are several sources of error in the use of these samplers including systematic errors associated with the samplers themselves. Field testing of the Scoop, Canadian Drag Bucket, US BM-54 and US BMH-53 in the South Saskatchewan River at Saskatoon was carried out by collecting 50 replicate samples with each sampler from each of three verticals in a cross-section. The results show significant differences in particle size obtained using different samplers at a given vertical. These differences are particularly pronounced (up to 30% for D_{50}, and greater for the tails of the distribution) in silty sand where the Scoop and Canadian Drag Bucket fail to retain much of the fine sediment.

The statistical error in the replicate samples with a given sampler is quite variable between samplers and between verticals, but except in well-sorted, medium sand, multiple samples would be needed in almost all cases to determine D_{50} to within 10% with a probability of error of 0.1. The average sample mass collected by each of the samplers is easily sufficient to satisfy the ISO criterion for sample mass. Spatial variability in particle size along a 500 m reach of the river is as great as the sampling errors and between-sampler differences at a single vertical.

It is recommended that the US BM-54 (or 60) be adopted as the standard bed-material sampler for larger sand-bed streams and that further research be carried out to find the most suitable sampler for shallow (wadeable) sand-bed streams.

RÉSUMÉ

Aussi disponible en français.

AYLESWORTH, R. and CASHMAN, M.
SEDEX System Operations Manual, First Edition, 41 p., 1977.

SUMMARY

This is the first edition of a manual of instruction for the SEDEX file. It describes the procedures for submitting and processing descriptive information for sediment stations. The purposes of the SEDEX file are: to provide management statistics like the total number of active stations by province, district, or the number of automatic samplers currently in use, etc.; to produce computer listings suitable for publishing the Sediment Data Reference Index; to produce computer listing suitable for distribution to users. The system of computer files and programs described in the manual run of the CDC Cyber 74 computer of the Department of Energy, Mines and Resources.

BINDA, G.G.

Ontario Sediment-Related Literature: Annotated Bibliography, 250 p., 1987.

ABSTRACT

This report consists of a compilation of reference material pertaining to sediment in Ontario streams and lakes (excluding the Great Lakes).

It is divided into two sections: 1) references and abstracts and 2) a subject cross-reference index. Subjects cover a wide range of interests such as quality aspects of sediments (adsorbed contaminants and metals), erosional processes, sediment transport in rivers, sedimentation in reservoirs and lakes, and water quality aspects. In addition the subject list contains the names of the rivers and lakes.

RÉSUMÉ

Ce rapport est un catalogue de références concernant les sédiments dans les rivières et lacs de l'Ontario (escluant les Grand Lacs).

Il est divisé en deux sections : 1) références et résumés et 2) un index de renvois par sujet. Les sujets englobent une large gamme d'intérêts tels la qualité des sédiments (contaminants et métaux adsorbés à la surface), les processus d'érosion, le transport de sédiments dans les rivières, la sédimentation dans les réservoirs et les lacs et la qualité des eaux. En plus, la liste de sujets contient les noms des rivières et lacs.

BINDA, G.G.

Sediment Data Reference Index for Ontario, 309 p., 1987.

ABSTRACT

This report consists of a reference index of available sediment data (fluvial and lacustrine, except for the Great Lakes) for Ontario. It is divided into a section on data collected by various public and private agencies and a second on data contained in published specific studies.

Both sections are separated alphabetically by major drainage basins within which the individual stations or rivers are also listed alphabetically.

Information available in the index are station name, number and location, collecting agency, sampling method, station purpose and the period of record for 1) suspended sediment (concentrations, loads and particle size), 2) bedload, 3) bed sediment particle size and 4) dissolved solids.

RÉSUMÉ

Ce rapport est un index de référence portant sur les données en sédiments (fluviaux et lacustres, à l'exception des Grands Lacs) disponible pour l'Ontario. La première section identifie les données recueillies par des agences publiques et privées. Une deuxième section identifie les données contenues dans les études spécifiques publiées.

A l'intérieur de chaque section, les données sont référées alphabétiquement selon les bassins versants principaux et leurs stations ou rivières.

Les informations fournies par cet index sont le nom, le numéro et la localisation de la station, l'agence des prélèvements, la méthode d'échantillonnage, l'objectif de la station et la période d'étude pour 1) les sédiments en suspension (concentrations, débits et granulométrie), 2) le charriage de fond, 3) la granulométrie des matériaux de lit et 4) les solides dissouts.

BINDA, G.G.

Sediment Station Analysis: Humber River at Elder Mills 02HC025, 309 p., 1987.

ABSTRACT

Sediment data have been collected at the hydrometric gauging station, Humber River at Elder Mills 02HC025, from 1966 to 1986. Station objectives were two-fold; first, to complement biological studies on fish spawning habitats and second, to collect information for possible reservoir construction in the basin.

This report conveys hydrometric, suspended sediment, bed material and dissolved solids information in various tabular, graphical and statistical ways.

An increasing trend in flow has been observed since 1972 which probably reflects changing climatic conditions. This trend has also been noted in other streams in Southern Ontario.

The total suspended sediment load transported over the 1967-1985 period was 4.9 x 10^5 tonnes with a mean annual load of 25.8 x 10^3 tonnes. More than 75% of the annual load is carried during the January to May period. Annual loads show a distinct peak over the 1974 to 1980 period. An increase in the load contributed by June to December flows has been observed since 1975. The causes for these trends are unknown.

Suspended sediment particles size data indicate that the material being transported is composed on average of 21% clays, 59% silts and 20% sands. Dissolved solids concentrations show an inverse relationship with discharge. The annual solute load is approximately 23 x 10^3 tonnes. A combined annual load (suspended sediment and dissolved solids) of 45 x 10^3 tonnes has been estimated.

A continuation of the current sampling program is recommended until all the clients information needs have been assessed and that the hydrological and sediment trends present in the basin are understood more clearly.

RÉSUMÉ

Aussi disponible en français.

BINDA, G.G. and DAY, T.J.
Sediment-Related Literature for the Western and Northern Region: Annotated Bibliography, 181 p., 1986.

ABSTRACT

This report consists of a compilation of reference material pertaining to sediment in the Western and Northern Region of Inland Waters Directorate, Environment Canada.

It is divided into two sections: 1) references and abstracts and 2) a subject cross-reference index. Subjects cover a wide range of interests such as quality aspects of sediments, erosional processes, sedimentation in reservoirs, lakes and rivers and sediment transport in rivers.

RÉSUMÉ

Ce rapport est un catalogue de références concernant les sédiments dans la région de l'Ouest et du Nord, Direction des eaux intérieures, Environnement Canada.

Il est divisé en deux sections: 1) références et résumés et 2) un index de renvois par sujet. Les sujets englobent une large gamme d'intérêts tels la qualité des sédiments, les processus d'érosion, la sédimentation dans les réservoirs, les lacs et les rivières et le transport de sédiments dans les rivières.

BINDA, G.G., DAY, T.J., and SYVITSKI, J.P.M.
Terrestrial Sediment Transport into the Marine Environment of Canada: Annotated Bibliography and Data, 79 p., 1986.

ABSTRACT

This report consists of a compilation of reference material pertaining to sediment transport into the marine environment of Canada. It is divided into three sections: 1) references and abstracts, 2) tables showing Water Survey of Canada data and data contained in specific studies and 3) a map showing the sites with available data.

RÉSUMÉ

Ce rapport est un catalogue de références concernant le transport de sédiments à l'environnement marin du Canada. Il est divisé en trois sections: 1) références et résumés, 2) tableaux illustrant les données compilées par la division des relevés hydrologiques du Canada et celles contenues dans des études particulières et 3) une carte indiquant la localisation des sites étudiés.

BISHOP, C.T. and ZRYMIAK, P.
Impact of the Rubblemound Breakwater at Goderich Harbour on Coastal and Fluvial Processes, 45 p., 1990.

ABSTRACT

An environmental monitoring program has been conducted at Goderich Harbour for four years to assess the impact of a new rubblemound breakwater on local coastal and fluvial processes. Hydrographic surveys were carried out to determine changes in water depth and in sediment erosion/deposition patterns. Bed material surveys were carried out to identify initial conditions and to document changes. Results from 1984 to 1988 indicate no adverse environmental impacts due to the new breakwater. However, significant subsidence of the lake bottom in the vicinity of the harbour is taking place as a result of subsurface salt mining activity.

RÉSUMÉ

Un programme de surveillance environnementale a été mené au port de Goderich pendant une durée de quatre ans afin d'évaluer l'incidence d'un nouveau brise-lames en enrochement sur les processus littoraux et fluviaux locaux. Des levés hydrographiques ont été effectués pour déterminer les variations de la profonduer de l'eau et des configurations d'érosion et de dépôt de sédiments. Des relevés des matériaux du fond ont été effectués afin de permettre l'identification des conditions initiales et pour documenter les changements. Les résultats obtenus de 1984 à 1988 indiquent que le brise-lames n'a aucune incidence environnementale nuisible. Cependant, il y a un affaissement important du fond du lac aux environs du port en raison de l'activité d'exploitation minière souterraine du sel.

BLACHFORD, D.P. and DAY, T.J.

Sediments in Water Quality Assessments: Opportunities for Integrating Water Quality and Water Resources Branches Activities, 60 p., 1988.

EXECUTIVE SUMMARY

Inland Waters/Lands has opportunities for integration of operational activities in addressing the issue of the role of fluvial sediments in environmental quality. These sediments, particularly their fine proportions, play a dominant role in the quality of the aquatic environment as they are capable of transporting quantities of nutrients and contaminants to and within aquatic systems, and of regulating nutrients and contaminant availability to the biological community.

Determining the status of aquatic quality is the primary responsibility of Water Quality Branch. Water quality assessments conducted by the Branch provide data and information regarding aquatic quality. The goals of the assessments are to establish for environmental impact assessments and to monitor for the development of or compliance with water quality objectives. The Sediment Survey Program of Water Resources Branch provides data on particle size and sediment concentration as well as information on seasonal and spatial variability of suspended sediment in fluvial and lacustrine systems. The goals of the assessment can only be met with the availability of this type of physical sediment data.

The roles of Water Quality and Water Resources Branches can be linked with regards to the procurement and usage of sediment data as part of water quality assessments. Water Resources Branch through its Sediment Survey activities provides expert advice on sediment dynamics, environmental processes and interpretation. A unique and important opportunity exists to address sediment issues be they toxic-related or simply a physical characteristic capable of limiting bioproductivity.

This report identifies opportunities for a new and improved working relationship between the Branches.

BRIMLEY, W.A.
A Hydrographic Data Acquisition System for River and Reservoir Morphological Studies, 25 p., 1977.

ABSTRACT

An electronic data collecting system has been developed by the Sediment Survey, Fisheries and Environment Canada, to facilitate the collection, reduction and analysis of data required to study the sedimentation rates and distributions in rivers, reservoirs, and estuaries. The data collection system is comprised of two dynamic distance measuring devices, an echo-sounder/digitizer, a precision electronic digital clock, a data coupler, a magnetic tape recorder, a micro-computer, and a plotter and printer. The system is coupled with a series of computer programs to process and analyze the data and has been instrumental in keeping with the demand for morphological studies without increasing personnel.

An outline of the system with some examples of the type of information collected is provided. A brief look at some future developments is also outlined.

CARSON, M.A.

An Assessment of Problems Relating to the Source, Transfer and Fate of Sediment along the Mackenzie River, NWT, 115 p., 1988.

EXECUTIVE SUMMARY

This report describes, in some detail, the major issues related to sediment transport along the Mackenzie River downstream of Great Slave Lake. It is organized in three parts.

Part One provides a background to the study, describes the general character of the Mackenzie river, and summarizes the eleven sediment-related issues identified. Part Two deals with each of these eleven concerns, individually, according to the following format: the issue itself; information needs for addressing the issue; adequacy of existing information available; and recommendations for further work necessary to remedy deficiencies in current knowledge. Part Three provides a summary of the recommendations (with some indication of their priorities) and a list of publications consulted in the work.

Eleven major issues are identified. The first five deal with sediment transported in suspension by the Mackenzie; the last six concern sediment found on the river bed. There is some degree of linkage between the two groups of problems, because some of the material on the river bed actually moves in suspension at high flows. Most of the suspended load, however, is not derived from the river bed. The eleven issues are:

1. the magnitude, timing and spatial pattern of influx of suspended sediment from the river to the Beaufort Sea: these are key factors controlling the offshore sediment plume (and its relationship to marine productivity), rates of infill of pipeline trenches, seabed stability etc.;

2. inputs of suspended sediment to the Mackenzie Delta as this affects the rate of build-up of the Delta surface - a crucial issue in view of fears of future submergence of the Delta with increasingly rapid rates of local sea level rise and possible permafrost degradation due to global warming;

3. the magnitude, timing and spatial pattern of nutrient supply to the Delta and the Beaufort Sea, bearing in mind that much of the nutrient load is bound to the fine-grained suspended load of the river;

4. the transport of contaminants (hydrocarbons, heavy metals etc.) to the Delta and the Beaufort Sea, many of which are also moved primarily in association with the fine-grained fraction of the suspended load;

5. identification of the main tributary sources of the suspended load of the Mackenzie, so that the impact of land use changes in these tributaries (e.g. damming of the Liard for hydro power) on the inputs of sediment, nutrients and contaminants at the mouth of the Mackenzie can be assessed in advance of the changes;
6. transport rates of bed material along the channel floor of the Mackenzie, partly to enable calculation of inputs to the Delta (and

hence allow assessments of the stability of Delta channels in the years ahead), but more generally to provide a scientific basis for answering more specific issues considered next (7-11) that hinge on the rate of transport of bed material in the channel;

7. shoaling of sediment in key reaches of the Mackenzie bed, as it affects navigation and the need for channel dredging-especially in relation to the increased traffic in the years ahead associated with oil and gas development;

8. the need to acquire a better understanding of the processes of scour and fill of the bed and banks, under ice and breakup conditions, especially in relation to the stability of pipeline crossings of the mainstem;

9. the need to acquire a better understanding of the role of shoals of sandy bed sediment in localizing ice jams during spring breakup, with the goal of eliminating, reducing or at least predicting, flooding associated with such ice jams;

10. the rapid expansion of the artificial islands at Norman Wells by trapping of sediment, and the implications of this for navigation and ice jams in the local area;

11. the environmental consequences of possible extraction of large quantities of granular material from the bed of the Mackenzie, particularly in connection with pipeline construction along the valley axis.

Recommendations are made for future work needed to supplement existing data in order to address the issues raised above. The major recommendations may be summarized as follows:

(a) an immediate, in-depth, review of the data for the five main sediment stations on the lower Mackenzie system, to establish whether or not sufficient data exist to develop numerical models for the prediction of suspended sediment loads (broken down by particle size and timing) at these sites from routinely collected hydraulic data such as discharge, water temperature etc.; this will enable decisions to be taken as to whether routine sampling can be terminated at these stations, allowing redeployment of resources elsewhere;

(b) a similar analysis of annual loads of bed material sediment in key reaches of the river by analysis of bathymetric charts in areas where repeat surveys have been undertaken by the Canadian Hydrographic Service;

(c) following (b), resurveys of key reaches of the river to allow updating of data to the 1980's, and to rectify gaps in the data file;
(d) following (a), addition of new sediment stations to the Mackenzie network allowing routine monitoring of suspended material in key reaches: Wrigley, Norman Wells and Fort Good Hope, and at the mouths of the three main Delta channels;

(e) following (d), once the sediment regime at these new stations has been established, expansion of the programme at these sites to include nutrients, hydrocarbons and heavy metals;

(f) an increase in basic research into ice-jamming in relation to shoaling and into the effects of an ice cover on bed scour.

Above all, an agency should be established to ensure full coordination of sediment and water-related issues in the Mackenzie basin downstream of Great Slave Lake. At the present time, it is apparent that many agencies are pursuing investigations into water and sediment in the Mackenzie corridor without appreciating that their work is related, often intimately, to other studies by other agencies. In addition, much of the data collection is not standardized among different agencies, with different techniques of sampling, storage and analysis; as a consequence, results are often difficult to compare.

It is also readily apparent that, while acquisition of sediment data in the North is expensive, and while it often cannot be justified on the basis of a single agency's concerns, sediment issues in the Mackenzie touch so many different departments that failure to acquire the data cannot be justified either. The obvious solution is greater cooperation among departments, and some form of inter-departmental (including private enterprise) cost-sharing.

CARSON, M.A.
Mackenzie River, NWT: Sediment-Related Issues and Recommendations, 71 p., 1988.

EXECUTIVE SUMMARY

This planning document describes, in some detail, the major issues related to sediment transport along the Mackenzie River downstream of Great Slave Lake. Eleven major issues are identified. These are:

1. the magnitude, timing and spatial pattern of influx of suspended sediment from the river to the Beaufort Sea: these are key factors controlling the offshore sediment plume (and its relationship to marine productivity), rates of infill of pipeline trenches, seabed stability etc.;

2. inputs of suspended sediment to the Mackenzie Delta as this affects the rate of build-up of the Delta surface - a crucial issue in view of fears of future submergence of the Delta with increasingly rapid rates of local sea level rise and possible permafrost degradation due to global warming;

3. the magnitude, timing and spatial pattern of nutrient supply to the Delta and the Beaufort Sea, bearing in mind that much of the nutrient load is bound to the fine grained suspended load of the river;

4. the transport of contaminants (hydrocarbons, heavy metals etc.) to the Delta and the Beaufort Sea, many of which are also moved primarily in association with the fine grained fraction of the suspended load;

5. identification of the main tributary sources of the suspended load of the Mackenzie, so that the impact of land use changes in these tributaries (e.g. damming of the Liard for hydropower) on the inputs of sediment, nutrients and contaminants at the mouth of the Mackenzie can be assessed in advance of the changes;

6. transport rates of bed material along the channel floor of the Mackenzie, partly to enable calculation of inputs to the Delta (and hence allow assessment of the stability of Delta channels in the years ahead), but more generally to provide a scientific basis for answering more specific issues considered next (7-11) that hinge on the rate of transport of bed material in the channel;

7. shoaling of sediment in key reaches of the Mackenzie bed, as it affects navigation, and the need for channel dredging especially in relation to the increased traffic in the years ahead associated with oil and gas development;

8. the need to acquire a better understanding of the processes of scour and fill of the bed and banks, under ice and breakup conditions, especially in relation to the stability of pipeline crossings of the mainstem;

9. the need to acquire a better understanding of the role of shoals of

sandy bed sediment in localizing ice jams during spring breakup, with the goal of eliminating, reducing or at least predicting, flooding associated with such ice jams;

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b. a similar analysis of annual loads of bed material sediment in key reaches of the river by analysis of bathymetric charts in areas where repeat surveys have been undertaken by the Canadian Hydrographic Service;

c. following (b), resurveys of key reaches of the river to allow updating of data to the 1980's, and to rectify gaps in the data file;

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e. following (d), once the sediment regime at these new stations has been established, expansion of the programme at these sites to include nutrients, hydrocarbons and heavy metals;

f. an increase in basic research into ice-jamming in relation to shoaling and into the effects of an ice cover on bed scour.

Above all, an agency should be established to ensure full coordination of sediment and water-related issues in the Mackenzie basin downstream of Great Slave Lake.

CARSON, M.A. and ASSOCIATES
Evaluation of Sediment Data for the Lower Athabasca River Basin, Alberta, 56 p. plus tables and figures, 1990. (final report)

ABSTRACT

This report provides a review of the stream sediment data collected by the Water Survey of Canada, Environment Canada, in the lower Athabasca River basin. Sediment data have been collected at 15 sites within this study area; two sites on the main stem Athabasca River (at Fort McMurray and at Embarras Airport), one on the Clearwater River, the major tributary within the study area, and at twelve sites on smaller tributaries.

The purpose of this report is to provide sediment data users, both engineers and environmental scientists, with a summary of available sediment data within the study area. It also contains an analysis of the suspended sediment regime as to concentration levels and trends, and an analysis of loads and yields. Some insight on sources and fates of suspended sediments is also provided.

RÉSUMÉ

Le présent rapport est un examen des données sur les sédiments des cours d'eau recueillies par Environnement Canada lors de son Relevé hydrographique du Canada effectué dans le bassin inférieur de la rivière Athabasca. Les données ont été recueillies dans 15 sites situés à l'intérieur de cette zone dont deux sur le cours principal de l'Athabasca (à Fort McMurray et à l'aéroport d'Embarras), un sur la rivière Clearwater - principal affluent de l'Athabasca dans la zone d'étude - et douze sur des affluents plus petits.

Le but de ce rapport est de fournir aux utilisateurs de données sur les sédiments - ingénieurs et environnementalistes - un sommaire des données disponibles sur les sédiments de la zone d'étude. Le document comprend également une analyse du régime des sédiments en suspension portant sur leurs taux de concentration et leurs tendances, de même qu'une analyse de leurs charges et rendements. Il nous éclaire aussi sur les origines et le sort des sédiments en suspension.

CARSON, M.A. and ASSOCIATES

Evaluation of Sediment Data for the Peel River above Fort McPherson and the Arctic Red River near Martin House Northwest Territories, 57 p. plus tables, figures and appendices, 1989.

EXECUTIVE SUMMARY

Sediment and hydrometric programs were established on the Peel and Arctic Red Rivers during the early 1970's in an attempt to assess the magnitude and timing of inputs of suspended sediment to the Mackenzie Delta and to the Beaufort Sea. The programs were companion to those on the Mackenzie River itself just upstream of the Arctic Red confluence. The two sediment programs were abandoned after only a few years, although the hydrometric programs continue.

The purpose of this report is to assess the adequacy of the sediment data in relation to the program's objectives; to indicate limitations of the data, and methods of rectifying these problems; and to provide estimates of the magnitude, timing and grain size composition of the suspended load on both rivers, as far as present data allow.

Preliminary analysis of the Peel data by Lewis showed that its mean load (1974-83) amounted to 25% of the combined input (Mackenzie, Peel, Arctic Red) of suspended sediment to the Delta, and that 85% of its load was concentrated in May and June. Both of these figures seem to be too high, however, in light of the present analysis.

One of the problems in computing loads on the Peel is overestimation of discharge during and after breakup. Until recently no gauging had been done under these high-water conditions, and water levels (used to infer discharge) are well above average during May and June because of backwater effects from the Delta. This inflation of discharge is incorporated in the calculation of sediment loads. A major attempt to gauge the Peel was made during the spring of 1968, but revised discharge data are not yet available for past years. The sediment loads given in the present report will therefore need to be updated.

An additional problem on the Peel was the large amount of scatter in the sediment rating diagram used to predict sediment concentration from daily discharge. Analysis of the 1970's files indicates that most of these concentration data - collected by observers - are suspect and should not be used. The exception is the data collected by WSC itself at the measurement section, but the number of such points is relatively small.

Additional sediment data collected on the Peel in 1988 (at a single vertical site) show much less scatter on the sediment rating diagram than the 1970's data, but require more multiple-vertical (MV) samplings to enable adjustment of the single vertical data to full cross-section values.

The best current estimate of the 1973-1984 mean annual suspended load on the Peel is that based on the MV samplings: this amounts to 23 Mt, substantially less than the preliminary figure of 31 Mt given by Lewis. This new figure (which is probably still to high because of overestimates in spring flows) corresponds to a mean concentration of 950 mg/L and a specific yield of 325 t/km^2/yr, both very high values.

The suspended load of the Peel is dominated (up to 70% in the spring) by silt, but clay size sediment increases to more than 30% during summer floods. The bed material, though sandy, also contains about a third silt-clay in shoal areas of the bed. Erratic suspension of silty bed material has probably contributed to scatter in the sediment rating.

The fine-grained character of the Peel bed near Fort McPherson contrasts with not only that of the Mackenzie at Arctic Red, but also the Arctic Red itself (both sandy). It is speculated that this may be related to low water-surface slopes (due to backwater effects from the Delta) leading to deposition of some of the suspended load.

Discharge and sediment data seem to be much more accurate for the Arctic Red River. The only concern is the lack of calibration of the SV site with MV sampling at the measurement section. The MV data do, however, fit the SV-controlled sediment rating very closely, suggesting that any bias is small. Additional MV samplings at high discharges are, however, needed.

Gaps in the hydrometric record, its relative brevity, and the occurrence of high return period floods in 1974 combine to make assessment of longterm monthly loads subject to appreciable error, especially for August. Application of the sediment rating over many more years of discharge data is still needed in order to estimate these long term means with confidence.

The mean annual suspended load for 1974-86 is estimated at 6.5 Mt, equivalent to a mean concentration of 1350 mg/L, and a specific yield of 345 t/km^2/yr. These - comparable with those of the Peel - are very high even for basins in the Western Cordillera. It is speculated that much of the sediment may originate from erosion of fine-grained glaciolacustrine sediments in these two basins. The grain size data for suspended sediment on the Arctic Red are similar to those of the Peel.

The sediment data for both rivers need to be recomputed following revision of discharge data (currently being done) and additional MV sampling. It seems inappropriate to prepare a user-oriented sediment station report for these two rivers until such time as these revisions have been made.

CARSON, M.A. and ASSOCIATES
Evaluation of Sediment Transport Data for the Lower Athabasca River Basin, Alberta, 117 p. plus tables and figures, 1989. Plus Appendix A - Miscellaneous Station Data, and Appendix B - Full Program Station Data printed in separate volumes. (interim report)

EXECUTIVE SUMMARY

This report provides a review of the stream sediment data in the Lower Athabasca basin of Alberta. It applies to stations on the Athabasca River at Fort McMurray and Embarras Airport, and tributary streams and rivers between these two stations.

The main purpose of the report is to provide the Water Resources Branch of Environment Canada with a technical evaluation of the quality of the data (in relation to past, present and future goals of the sediment program) and identification of additional work necessary to correct any gaps, inconsistencies and ambiguities in the data.

Though sediment data in the region are of interest to many agencies - especially in connection with oilsands development - the present report is not aims at external users of Water Resources Branch data. Such a report is more appropriately undertaken when the additional work just indicated has been completed.

The miscellaneous data collected on tributary streams are treated in Section 2; an overview of the full-program stations on the Athabasca and Clearwater Rivers is given in Section 3; and analyses of the data for the Clearwater River, for the Athabasca at (and below) McMurray and at Embarras Airport are undertaken in Section 4, 5 and 6 respectively. An overall evaluation of the program is provided in Section 7.

Summaries of the data analysis are presented at the end of each section. Estimates of daily concentrations and loads of suspended sediment are hampered by the limited extent of sampling at the tributary stations and by gaps in the sampling program at the full-program stations. The approach taken throughout, therefore, is to develop sediment rating curves - linking daily concentration to daily water discharge - and to use these for estimating concentration.

The approach is reasonably satisfactory on the tributary rivers except for Joslyn Creek (where sediment yields seem to be increasing over time) and Poplar Creek (where there is considerable scatter which seems to result, in part, from the Beaver diversion). The data show that regional differences in mean concentration seem to be consistent with that anticipated on the basis of the geology and physiography of the basins: highest at the Ells, Hangingstone and Joslyn stations (>300 mg/L); and lowest at the Muskeg and Hartley stations (<20 mg/L).

Most of the regular miscellaneous sampling programs could now be curtailed, though additional particle size data are needed; increased attention should be given to identifying sources of sediment in these basins. Continuation of the hydrometric programs is needed to ensure additional years of sediment-rating derived data, thus improving the precision of estimates of monthly mean values.

Several problems exist with the sediment data at the full-program stations; one is the use of dip-sampling; a second - and more serious - is inadequate calibration of the single-vertical site against the full cross-section. The sediment rating approach itself appears to be well-suited to these stations. On the Athabasca stations there is a seasonal decrease in concentration - relative to discharge - from April through to September, but the effect can be included in the statistical predictions by using monthly correction factors. The reason for the seasonal trend warrants study. Gaps in the hydrometric record are the main problem in computing monthly loads and concentrations. In particular, the value of the program at Embarras Airport is severely limited by the scarcity of discharge data for the month of April. The possibility of combining the Embarras sediment rating with simulated discharge data (using the station below McMurray) should be explored.

The mean concentration on the Clearwater R. is about 200 mg/L; the mean annual load is about 0.8 Mt with peak loads in May; more than a third of the suspended load is sand.

The data on the Athabasca are hard to interpret for reasons given. The mean concentration at McMurray and at Embarras Airport appears to be about 350 mg/L; the mean annual load is indicated to be about 6 Mt (peaking in July), with slightly lower loads at Embarras. The implication that sediment is deposited in the reach between these stations needs additional investigation. It is, nonetheless, consistent with a major contrast in the grain size of the suspended sediment at the two stations: a decrease in the percentage sand component from about 21% at the McMurray bridge to about 7% at Embarras.

Recommendations are made for remedial sampling at the full-program sites in 1989 in order that further analysis may be undertaken of the various problems encountered.

There appears to be a consensus among environmental agencies that greater attention needs to be paid to the chemical quality of sediment in these rivers, rather than the physical attributes of total concentration, loads, and grain size. The same problems that have confronted the Water Resources Branch in its sediment program - site selection, extrapolation of single-vertical data to full cross-section values, interpolation and extrapolation over time etc. - will necessarily confront programs aimed at monitoring the flux of contaminants in the suspended load. There seems to be considerable merit in utilizing the present sampling stations of the Water Resources Branch for any future program oriented to sediment quality.

The station at Embarras - downstream of the oilsands region - may be pivotal in such a program. The analysis undertaken in this report indicates several difficulties with the past hydrometric and sediment program at that station. These need to be considered in planning future work dealing with sediment quality in the Lower Athabasca region.

CARSON, M.A. and ASSOCIATES
Sediment Observations on the Mackenzie River Network: Summary and Recommendations for Future Work, 30 p., 1989.

PREAMBLE

This report presents a summary of three previous reports that were concerned with the evaluation of sediment data at the five main sediment sampling stations of the Water Survey of Canada in the lower Mackenzie basin, Northwest Territories: the Mackenzie River upstream of Arctic Red River (Carson, 1988b); the Liard River and the Mackenzie River upstream of the Liard River (Carson, 1988c); the Arctic Red near its mouth and the Peel River above Fort McPherson (Carson, 1989).

These reports are proprietary reports and not intended as summary documents for agencies interested in using the sediment data of the lower Mackenzie network. An appropriate user-document cannot be prepared until additional remedial sampling is done at these sites, and until discharge data, especially on the Peel and lower Mackenzie River, have been revised.

The assistance of numerous personnel attached to the Inland Waters Directorate in the preparation of these reports is acknowledged. Special thanks are due to Terry Day, Morley Cashman, and Joseph McIlhinney in Ottawa; Jack Wedel, Henry Westermann and Chris Heron in Yellowknife; Herb Wood and his staff in Inuvik; Pat Wood in Fort Simpson; and Richard Yungwirth in Regina.

PRÉAMBULE

Le présent rapport fournit un sommaire de trois rapports déjà parus au sujet de l'évaluation des données sur les sédiments aux cinq principales stations d'échantillonnage des sédiments que possède la Division des relevés hydrologiques du Canada dans le bassin inférieur du Mackenzie, dans les Territoires du Nord-Ouest. Il s'agit plus précisément des stations suivantes : fleuve Mackenzie en amont de la rivière Arctic Red (Carson, 1988b); rivière Liard et fleuve Mackenzie en amont de la rivière Liard (Carson, 1988c); rivière Arctic Red près de son embouchure et rivière Peel en aval de Fort McPherson (Carson, 1989).

Ces rapports sont la propriété de la Division et ne visent pas à servir de sommaires pour les organismes intéressés à utiliser les données sur les sédiments pour le réseau du bassin inférieur du Mackenzie. Il faudra effectuer d'autres échantillonnages correcteurs à ces stations et réviser les données sur le débit, notamment pour la rivière Peel et le bassin inférieur du Mackenzie avant d'être en mesure de produire un document approprié à l'intention des utilisateurs.

Nous remercions les nombreuses personnes de la Direction générale des eaux intérieures qui ont collaboré à la préparation de ces rapports et notamment Terry Day, Morley Cashman et Joseph McIlhinney d'Ottawa; Jack Wedel, Henry Westermann et Chris Heron de Yellowknife; Herb Wood et son personnel à Inuvik; Pat Wood de Fort Simpson; et Richard Yungwirth de Regina.

CASHMAN, M.A.
Automated Suspended Sediment Computations, 54 p., 1973.

SUMMARY

This manual provides instructions for digitizing hydrometric records. It digitizes a reconstructed concentration curve on a Pencil Follower to obtain punched cards containing the X and Y co-ordinates. A Pencil Follower is a manually-operated electronic device which converts data presented as graphs, charts, drawings, photographs and films into digital form for subsequent automatic data processing for computer use. With the punched cards and the card decks defining the updating corrections, a computer program can be used to obtain daily mean concentrations in mg/L. The digitized concentration charts can be plotted, the daily mean concentration hydrograph for linear or logarithmic scales can be plotted, and card output of daily mean concentrations are possible with the computer program.

CASHMAN, M.A.

A Compilation of Sediment Survey Report Series Abstracts 1984 to 1989, 122 p., 1990.

PREFACE

This document presents a compilation of abstracts or summaries from eighty publications, Sediment Survey report series and manuals from the Water Resources Branch for the years 1984 to 1989. Included also are two unnumbered reports published in 1974 by R. Kellerhals, et al., and 1983 by T.R. Yuzyk.

Abstracts or summaries are copied directly from the reference reports and are organized in alphabetical order by Author.

PRÉFACE

Le présent document présente une compilation de résumés de quatre-vingt publications parues entre 1984 et 1989 dans la série des rapports et de manuels sur l'étude des sédiments de la Direction des ressources en eau. En font également partie deux rapports non numérotés publiés en 1974 par R. Kellerhals et coll. et en 1983 par T.R. Yuzyk.

Les résumés sont copiés directement du rapport cité et sont classés par numéro de série selon l'auteur.

CASHMAN, M.A.
Digitizing Procedures for Suspended Sediment Data, 49 p., 1988.

PREFACE

The Water Resources Branch of the Department of Environment is responsible for the national program of collecting, analyzing and disseminating water quantity data and to provide information and advice, concerning this aspect of Canada's inland waters. Water quantity or hydrometric data consists mainly of water levels, flows and sediment transport.

Sediment Survey Field and Office Manuals are prepared to define and describe standard procedures and practices to be followed by Water Resources Branch personnel in the collection, processing, computing and publication of Sediment Survey data.

Sediment Survey Manuals are also used as basic training aids by Water Survey of Canada technicians who are progressing through their career development program. Standards defined within the manuals reflect the optimum procedures and practices in their time and therefore, cannot be considered static. Suggestions to effect change will be welcome and will be given careful consideration.

This manual of Digitizing Procedures for Suspended Sediment Data was prepared by the Sediment Survey Section of the Water Survey of Canada Division in Hull. Contributions in the form of suggestions and revisions were received from region offices of the Water Resources Branch and are gratefully acknowledged.

While this manual and selected other manuals released by the Water Resources Branch are intended for internal use, they are available on request to any other agencies or to individuals.

CASHMAN, M.A.

Laboratory Procedures for Sediment Analysis, Second Edition, 78 p., 1988.

PREFACE

The Water Resources Branch of the Department of Environment is responsible for the national program of collecting, analyzing and disseminating water quantity data and for providing information and advice concerning this aspect of Canada's inland waters. Water quantity or hydrometric data consist mainly of water levels, flows and sediment transport.

Field and Office Manuals are prepared to define and describe standard procedures and practices to be followed by the personnel in the collection, processing, computing and publication of surface water data.

Sediment Manuals are used as basic training aids by Water Survey of Canada technicians who are progressing through their career development program. Standards defined within the manuals reflect the optimum procedures and practices in their time and therefore, cannot be considered static.

PRÉFACE

La Direction des ressources en eau du ministère de l'Environnement est responsable du programme national de collecte, d'analyse et de diffusion des données sur la quantité des eaux. Elle est également chargée de fournir renseignements et conseils ayant trait à la quantité des eaux intérieures canadiennes. Les données sur la quantité des eaux, ou données hydrométriques, concernent principalement le niveau d'eau, le débit et le transport des sédiments.

Les manuels pratiques et les manuels théoriques servent à définir et à décrire les méthodes et pratiques courantes que doit suivre le personnel de la Direction pour la collecte, le traitement, le calcul et la publication des données sur les eaux de surface.

Quant aux manuels sur les sédiments, ils servent de matériel pédagogique de base aux techniciens de la Division des relevés hydrologiques du Canada qui progressent dans le cadre du Programme de formation professionnelle. Les normes définies dans les manuels traduisent les meilleures méthodes et pratiques disponibles au moment de leur publication et peuvent donc être appelées à changer.

CASHMAN, M.A.

Office Procedures for Sediment Data Computations, First Edition, 35 p., 1978.

SUMMARY

This manual describes the office procedures involved in the computation of data for standard sediment survey stations, and contains detailed instruction to ensure that national standards and uniformity are maintained throughout the Water Survey of Canada in the office procedures involved in the computation of sediment survey data.

Basic data are collected and computed by District personnel and submitted to Ottawa for publication. Although parts of the suspended sediment data computation procedures have been automated, certain operations will continue to be performed manually. A digitizer/card punch system is operational in each District. Computer programs for digitizer applications and related computations are written by Data Control Section staff at Ottawa and then implemented in the Districts at local Computer Centres. Automated procedures have been developed at Ottawa for the preparation of a camera-ready manuscript for the Sediment Data Reference Index, the annual Sediment Data Canadian Rivers and the Historical Sediment Data Summary publications; data are also available to users on magnetic tape.

CASHMAN, M.A
Office Procedures for Sediment Data Computations, Second Edition, 60 p., 1988.

PREFACE

The Water Resources Branch of the Department of Environment is responsible for the national program of collecting, analyzing and disseminating water quantity data and to provide information and advice, concerning this aspect of Canada's inland waters. Water quantity or hydrometric data consists mainly of water levels, flows and sediment transport.

Sediment Survey Field and Office Manuals are prepared to define and describe standard procedures and practices to be followed by Water Resources Branch personnel in the collection, processing, computing and publication of Sediment Survey data.

Sediment Survey Manuals are also used as basic training aids by Water Survey of Canada technicians who are progressing through their career development program. Standards defined within the manuals reflect the optimum procedures and practices in their time and therefore, cannot be considered static. Suggestions to effect change will be welcome and will be given careful consideration.

This manual of Office Procedures for Sediment Data Computations was prepared by the Sediment Survey Section of the Water Survey of Canada Division in Hull. Contributions in the form of suggestions and revisions were received from regional offices of the Water Resources Branch and are gratefully acknowledged.

While this manual and selected other manuals released by the Water Resources Branch are intended for internal use, they are available on request to any other agencies or to individuals.

CASHMAN, M.A.

Repeatability and Sensitivity for Suspended Sediment Analysis, Second Edition, 78 p., 1987.

ABSTRACT

This project was initiated to determine the repeatability of suspended sediment loads produced by standard Water Survey of Canada methods. The sensitivity of loading values were also examined. The study was conducted using the suspended sediment concentration data and the original records for 1969 for the sediment sampling station Assiniboine River at Headingley (05MJ001).

The awareness of uncertainties in sample collection techniques, computation, and their affect on the sediment loads, as well as concern for the increasing cost of collecting and analyzing suspended sediment samples have led to the review of sampling strategies. This included a review of the number of cross-section measurements taken, and the increased reliance on data obtained from single vertical sampling. The number of measurements and single vertical samples were reduced for each test.

The analysis indicates that the sample coverage can be reduced considerably. The usual high volume of sampling must be maintained during the freshet while sampling during the winter months can be deleted. The reduced sample collection resulted in a repeatability of the annual loads to within 5% while showing a reduction in laboratory costs of approximately 80%. This study also shows that large errors may affect individual days or short periods due to sampling strategies, but when comparing the total annual loads the differences are insignificant. Furthermore the results indicate that the use of the K factor is not warranted if total annual loads are the only interest.

RÉSUMÉ

Aussi disponible en français.

CASHMAN. M.A.
Sediment Survey Equipment Catalogue, 90 p., 1988.

INTRODUCTION

This catalogue was prepared to assist those involved in ordering sampling equipment for sediment investigations. This publication illustrates current instruments and supplies. Obsolete equipment has been omitted.

Equipment orders should be forwarded on a purchase order to the National Equipment Distribution Centre. Telephone inquiries are invited; but because most equipment items are property-controlled, equipment cannot be shipped before receipt of purchase order.

Because the National Equipment Distribution Centre has no budget it therefore operates on a non profit cost recovery basis. Equipment costs are based on the latest available price list from the "Federal Inter-Agency Sedimentation Project" St. Anthony Falls Laboratory. Costs for individual items are maintained at a minimum, consequently no discount is offered for quantity purchases.

All measurements and weights in this catalogue are given in metric units. The scale shown in most photographs is graduated every 1 cm and is 20 cm in length. For convenience purposes the following equivalents of the more common sampler weights and nozzle sizes are listed below.

Samplers

US DH-48 3.5 lb. - 1.6 kg
US D-59 22 lb. - 10.0 kg
US D-74 62 lb. - 28.1 kg
US P-61 105 lb. - 47.6 kg

Nozzles

Small 1/8 in. - 3.18 mm
Medium 3/16 in. - 4.76 mm
Large 1/4 in. - 6.35 mm

Because of the wide range of sampling conditions encountered and the variety of installations at measurement sites, a number of different depth-integrating and point-integrating samplers have been designed. Samplers suspended by cable are suitable for operating from bridges, cableways, and boats.

Reports pertaining to development and theory of equipment operation, and to sampling and computational methods are listed in the back of this catalogue. Questions regarding theory and operation should be addressed to the Head, Sediment Survey Section, WRB, Environment Canada, K1A 0H3, (819-953-1560).

CASHMAN, M.A.
Sediment Survey Surface and Dip Sampling Procedures, 6 p., 1984.

SUMMARY

The purpose of this statement is to inform Water Survey of Canada personnel of the technique for taking surface and dip samples. These are often "emergency" samples, when conditions such as high stream velocity or floating ice do not permit regular sampling techniques. The statement also contains information on subsequent sampling and documentation procedures necessary for correlation of the samples.

CASHMAN, M.A., CAVANAGH, G., and DURETTE, Y.J.
Automatic Suspended Sediment Pump Sampling, First Edition, 41 p., 1979.

SUMMARY

This is the first edition of a manual of instructions for the PVS Automatic Pump Sampler. The manual reviews on which types of streams the sampler would be appropriate, site selection, installation, operation, maintenance, and troubleshooting.

CASHMAN, M.A. and DAY, T.J.
Filtration of Suspended Sediment Samples using Various Filter Combinations, 19 p., 1984.

SYNOPSIS

Studies undertaken by the Guelph and Moncton sediment laboratories indicate that the asbestos fibre used as a filtering agent, and now considered to be a health risk, can be replaced without any apparent loss in the quality of results. Eight filters were tested. As sediment concentration increases so does the compatibility amongst the filtration methods, as does their overall accuracy. Below 250 mg/L results were inconsistent. Our analysis indicates that several of the tested filtration methods can be used as a replacement. However, due to inconsistencies in the testing procedures, and to some significant differences between the test results of the laboratories, no specific replacement can be clearly identified. The urgency for a replacement, however, does demand a choice and we recommend that the Whatman GF/C filter with AP 20 Prefilter method be adopted as an interim standard. A more thorough laboratory test study is considered to be required before a definite choice can be made.

CASHMAN, M.A. and SPITZER, M.O.
Sediment Station Analysis: South Saskatchewan River at Highway No. 41, 64 p. plus appendices, 1989.

ABSTRACT

Water Survey of Canada has collected sediment data at the South Saskatchewan River at Highway No. 41 (05AK001) since April 1966. This sediment station was established primarily to quantify the sediment input to Lake Diefenbaker. The report was prepared to evaluate whether the sediment program has met this objective and if so whether sufficient sediment data are now available to adequately document the sediment transport characteristics at this site.

Until 1978 the data were collected year-round but since then the station has only been operated seasonally, April to October. Suspended sediment data are collected at a generally stable cross section in which the bed material is predominantly sand with some gravel present.

Most of the annual load is transported during the peak flows in June. The mean annual suspended sediment load was 3.2×10^6 for the 12-year period 1967 to 1978, a period when annual flows were above average.

Existing particle size data are sufficient to characterize the particle-size distribution of the suspended sediment. The particle size distribution is dominated by silts and clays. Sediment samples collected by the point-integrated method reveal that the concentration is consistent both vertically and laterally across the channel. Sand particles are distributed proportionately throughout each sampling panel.

Results of this station review indicate that further intensive sample collection will not improve our general knowledge of the sediment transport at this site. It is, therefore, recommended that the detailed sampling program be replaced by a miscellaneous program focusing on the range of discharges that have not yet been sampled.

A by-product of this study is the compilation of all available sediment data into one package and the presentation of various pertinent sediment data features in tabular and graphical formats. Thus the report will be a useful tool for engineers, geomorphologists and environmentalists working on projects on the South Saskatchewan River.

RÉSUMÉ

Aussi disponible en français.

CHURCH, M., KELLERHALS, R., and DAY, T.J.
"Regional Clastic Sediment Yield in British Columbia", Canadian Journal of Earth Sciences", Vol. 26, No. 1, p. 31-45, 1989.

ABSTRACT

The data archive of the Water Survey of Canada, supplemented by data of the British Columbia Hydro and Power Authority, is used to investigate the areal pattern of fluvial sediment yield in British Columbia. The data represent suspended sediment loads at 63 stations derived from observations within the period 1966-1985. In most of the province there is a single annual peak in sediment transport in spring, corresponding to the dominant snowmelt freshet. However, on the coast winter rainfall induces the sediment peak, and in the Coast and Cascade mountains there is a transitional regime with two peaks. From 65 to 90% of annual sediment yield occurs in the spring three months. Sediment yield per unit area (specific sediment yield) increases with drainage area at all scales from 10 up to 30 000 km^2. The pattern persists seasonally throughout the year. This contradicts the conventional model in which sediment yield declines downstream because of deposition along channels of a portion of the load derived from erosion of the land surface. In British Columbia much of the sediment derives from erosion of Quaternary materials along stream banks and valley sides. Rivers draining glaciers and lakes behave distinctively. The observed pattern of sediment yield complicates prediction of drainage-basin sediment yield.

RÉSUMÉ

Les données des archives de la Commission des Eaux du Canada, complétées par les données du Hydro and Power Authority de la Colombie-Britannique, ont été utilisées pour déterminer la mode spatiale de production de sédiments fluviatiles en Colombie-Britannique. Les données représentent les charges de sédiments en suspension de 63 stations, telles que fournies par les observations faites durant la périod 1966-1985. Pour la majeure partie de la province, il n'existe sur la courbe de transport de sédiments qu'un seul pic annuel, au printemps, correspondant à la crue dominante de la fonte des neiges. Cependant, sur la côte, ce sont les chutes de pluie de l'hiver qui produisent le pic de la courbe de transport sédimentaire, et dans les chaînes Côtières et les Cascades le régime est transitionnnel et caractérisé par la présence de deux pics. Les trois mois du printemps fornissent de 65 à 90% de la production annuelle de sédiments. La production de sédiments par unité de surface (production spécifique de sédiments) s'accroît avec l'aire drainée, et ce à toutes échelles comprises entre 10 et 30 000 km^2. Ce mode de production de sédiments ne varie pas d'une saison à l'autre durant l'année. Ces observations sont en désaccord avec le modèle conventionnel, lequel soutient qu'il y a diminution de la production de sédiments en direction aval des cours d'eau, à cause de la sédimentation le long des chenaux d'une partie de la charge dérivée de l'érosion de la surface des terres. En Colombie-Britannique une portion importante des sédiments provient de l'érosion de matériaux quaternaires le long des berges des cours d'eau et des rebords des vallées. Les rivières qui drainent les glaciers et les lacs ont un comportement différent. Le mode de production de sédiments observé rend difficile la prédiction de la quantité de sédiments produite par les bassins versants.

CHURCH, M., KELLERHALS, R., and WARD, P.R.
Sediment in the Pacific and Yukon Region: Review and Assessment, 250 p., 1985.

SUMMARY OF RECOMMENDATIONS[1]

A. Issues with specific engineering and commercial implications.

B. Studies for improved understanding of sediment transport and deposition process, having general engineering implications.

C. Studies of water quality.

D. Development of standard instrumentation and methods.

E. Procedures in the Sediment Survey Programme.

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[1] Recommendations are in order of priority within, but not between, major categories.

CHURCH, M., McLEAN, D.G., KOSTASCHUK, R., MACFARLANE, S., TASSONE, B., and WALTON, D.
Channel Stability and Management of Lower Fraser River Field Excursion Guide, 99 p., 1990.

SUMMARY

This document reports on the channel stability of the Lower Fraser River, British Columbia. Chapter one provides information on basin morphology, hydrology, sediment sources, water quality, and salmon utilization. Chapter two is specific to the sediment budget of the river, including suspended and bed loads. Chapter three covers field work at six sites, these being Agassiz, Carey Point, Mission, Port Mann, Deas Island, and Steveston.

CHURCH, M., McLEAN, D.B., KOSTASCHUK, R., and TASSONE, B.
Sediment Transport in Lower Fraser River: Summary of Results and Field Excursion Guide, 42 p., 1987.

PREFACE

The studies reviewed in this field guide form part of an investigation of the processes governing channel stability and sedimentation in lower Fraser River. A major task is to develop a long term sediment budget for the reach to aid port management below Port Mann. Toward that end, this report gives a review of the available sediment transport observations on the river, which are amongst the more comprehensive available for any river. These have been reconsidered in light of current developments in the analysis of sediment transport measurements. As a result, some aspects of prior analyses have been substantially revised.

It should be realised, however, that the results presented here remain preliminary. They have not been approved by the Water Survey of Canada and should not be regarded as final or authoritative.

A series of reports has been issued to inform the client of progress in this project as follows:

Church, M. McLean, D., Mannerstrom, M. and Evans, D. 1984. Reference materials on sedimentation and morphology of the lower Fraser River. Environment Canada, Water Resources Branch, Sediment Survey Section.

McLean, D. and Mannerstrom, M. 1985. History of channel stability: lower Fraser River, Hope to Mission. Environment Canada, Water Resources Branch, Sediment Survey Section.

McLean, D. 1985. Lower Fraser River Survey, 1984: Agassiz-Rosedale Bridge to Mission. Environment Canada, Water Resources Branch, Sediment Survey Section.

McLean, D. and Church, M. 1986. A re-examination of sediment transport observations in the lower Fraser River. Environment Canada, Water Resources Branch, Sediment Survey Section.

CHURCH, M., McLEAN, D.G., MANNERSTRÖM, M.C., and EVANS, D.
Reference Materials on Sedimentation and Morphology of the Lower Fraser River, 243 p., 1985.

INTRODUCTION

This report presents a compilation of reference materials on the subjects of physical hydrology, sedimentation, morphology, and related engineering problems on the lower course of Fraser River, British Columbia. The "lower course" of the river is taken to mean the river between Yale and the sea, a distance of some 190 km (114 miles). This includes the entire length of the alluvial channel of the river below Fraser Canyon (cf. figure 1).

Between Yale and Hope (165 km; 99 mi. above the mouth), the river flows in a straight, single channel that is more or less constricted between Pleistocene terraces and, sometimes, bedrock. Below Hope, the river flows through its own floodplain and delta to the sea. Between Wahleach Creek (Laidlaw) and the mouth of Sumas River the channel is braided, and below that follows a single channel to the head of its "modern delta" at Port Mann, near the city of New Westminster. The lowermost 98 km (59 mi.) of the river's course may be subject to tidal influences during at least part of the year but, during the annual spring freshet tidal influence is much more restricted. Salt water is restricted to the lowermost few kilometres of the Douglas Island and corresponds to that part of the river that is substantially affected by tides.

There are several major channels connecting the river with major lakes on the north side of the floodplain, and several more or less insignificant tributaries flowing to the main river on the south side. These channels and their alluvial deposits are included within the purview of the bibliography, though there is relatively little published work to report.

In making decisions about what material to include, criteria were adopted:

1. The report attempts to be exhaustive in the central areas of clastic sedimentation and alluvial morphology. In relevant areas, such as physical hydrology and hydraulics, surficial geology, engineering and hydrological material was excluded--particularly relatively obscure reports that only incidentally contain information that is more explicitly or more readily available elsewhere. The particular subject of transport of dissolved materials has been included by listing major reports and sources of data. The general subjects of water quality and pollution of lower Fraser River waters have not been included, though.

2. The report is restricted to material making specific reference to Fraser River. General reference works are excluded.

3. The report is restricted to material that is publicly accessible. A great deal of valuable information has been gathered in the course of commissioned engineering investigations. In many cases, however, the results remain restricted either by confidentiality or by the simple fact that the reports remain in one or two copies in private hands. Such reports are not listed. Engineering and planning reports prepared for government agencies commonly become accessible for general or specific purposes and these are listed. The appearance of a reference in this report should not, however, be construed to mean that it is casually available.

4. The report does not list projects in progress.

5. References have generally been examined and confirmed by the writers, except as explicitly noted. In cases where the material has not been seen, it is included only if it has been reliably referenced in more than one source.

The bibliography is assuredly not complete. In several places, the existence of unexamined data resources is noted. Beyond that there are two particular areas of weakness:

(a) Historical materials related to the river, particularly photographic materials and local surveys: this material can only be uncovered by extensive search and fortuitous discovery. The work is beyond our resources.

(b) Engineering reports and other privately or irregularly published data. Companies, public agencies and individuals may often be willing to provide access for good purpose to materials that are nevertheless not noted or referenced elsewhere. In such cases, we have no means for systematically tracing materials.

CHURCH, M., MILES, M., and ROOD, K.
Sediment Transport along Mackenzie River: A Feasibility Study, 135 p., 1987.

INTRODUCTION

Although it is one of the major rivers of North America, the remoteness of Mackenzie River has discouraged study of it. Hence, channel hydraulics and sediment transport remain poorly known. Proposed resource developments along the river and the desirability to develop a regional water management plan now require that knowledge of these phenomena be improved more rapidly than could be achieved by the expansion of conventional monitoring programs alone.

Information on sediment transport characteristics can be obtained from non-traditional sources. Specifically, historic planimetric and topographic surveys, aerial photographs and hydrographic sounding, supplemented with limited observations of sediment transport, might be used to construct an approximate sediment budget on a reach-by-reach basis.

In the long term, understanding the viability of alluvial ecosystems requires that the character of erosion and sedimentation be understood on a reach basis. It is appropriate to draw evidence from morphological and sedimentary studies, rather than just from sediment transport monitoring, because information of the appropriate character and resolution can be gained in that way. Net change within reaches - rather than total throughput of sediment - is critical for river stability. Further, it requires many years' monitoring, conducted at great expense, to establish the trend of river stability. Where map, chart, or air photo evidence is available, trends can be established from the observed pattern of changing morphology.

Some monitoring remains important in order to permit more detailed interpretation of net morphological changes in terms of a sediment budget.

The present project resulted from a request by Dr. T.J. Day, Head. Sediment Survey of Canada, to Professor Michael Church, at the University of British Columbia, to consider whether map and photo records could be used to obtain useful information on Mackenzie River. Because there is relatively little information available on the river, it is prudent first to undertake a feasibility study of the approach.

COAKLEY, J.P. and BEAL, G.S.
SEDAN - A Computer Program for Sediment Particle-Size Analysis, 33 p., 1972.

ABSTRACT

SEDAN is a computer program written in FORTRAN IV to calculate the mean and the first three moments about the mean (variance, skewness measure and kurtosis measure) for a sediment particle-size distribution using the method of moments (Krumbein, 1936). A line-printer probability plot of the cumulative per cent versus size class and of the frequency histogram is included in the output from the program. In addition, the standard deviation, mode, percentages of sand, silt and clay, and the amount of sample fine than 9 phi (2 microns) are calculated and the sediment type is labelled using the Shepard (1954) textural nomenclature.

RÉSUMÉ

SEDAN est un programme pour ordinateur écrit en Fortran IV, pour l'analyse granulométrique d'un sédiment. Il permet de calculer la moyenne et les trois premiers "moments autour de la moyenne" (variance, mesure asymétrique et mesure de kurtosis), lors des études de distribution granulométrique d'un sédiment par la méthode des "moments" (Krumbein, 1936). Une représentation graphique du "pourcentage cumulé" reporté comme fonction de "classe granulométrique" ainsi que celle d'un histogramme de fréquence ont été incluses dans le "système de sortie" (output) du programme. Par ailleurs, la déviation standard et le mode, les pourcentages du sable, du silt et de l'argile, ainsi que la fraction de l'échantillon dont les grains possèdent un diamètre inférieur à 9 phi (2 microns) ont été calculés. Le nom de type du sédiment à été attribué selon la nomenclature texturale de Shepard (1954).

COLLIER, E.P.
Distribution of Suspended Sediment Concentration at Two Stream Stations in Manitoba, 62 p., 1979.

ABSTRACT

Increasing costs of obtaining and analyzing suspended sediment samples have lead to a reduced program in the number of total cross-sectional samplings and an increased reliance on data obtained from one vertical sampling by local observers or single point intake sampling by automatic samplers to compute suspended sediment yield. This project was initiated to study the cross-sectional variability of suspended sediment concentration and particle-size distribution in order to assist in the selection of sampling points or verticals and to assess the probable accuracy of the estimating methods.

The study was conducted using suspended sediment concentration and particle-size data, for the period 1962 to 1974, for the following two sediment sampling stations: Assiniboine River at Headingley (05MJ001) and Red River near Ste. Agathe (05OC012).

Further study on additional streams is planned and will be available in forthcoming publications.

RÉSUMÉ

À cause de l'augmentation des coûts du prélèvement et de l'analyse des échantillons de sédiments en suspension, il a fallu réduire le nombre d'échantillonnages sur la section transversale de cours d'eau et se fier davantage à l'échantillonnage d'une verticale, par des observateurs locaux, ou à l'échantillonnage ponctuel automatisé pour évaluer la concentration des sédiments en suspension. On a voulu étudier la variabilité de la concentration et de la granulométrie de ces sédiments en des points précis de la section transversale afin d'aider au choix des emplacements d'échantillonnage vertical ou ponctuel et d'évaluer l'exactitude probable de ces méthodes.

On a utilisé à cette fin des données portant sur la concentration des sédiments et leur granulométrie, recueillies de 1962 à 1974 à la station (05MJ001) à Headingley sur l'Assiniboine, et à la station (05OC012) près de Ste-Agathe sur la rivière Rouge.

On prévoit étendre les travaux à d'autres cours d'eau et publier les résultats dans des publications subséquentes.

CONSERVATION MANAGEMENT SYSTEMS

Ontario Perspectives on Sediment Issues - Phase I, Interim Report, 27 p., 1985.

INTRODUCTION

Background

This interim report presents preliminary results obtained during the first phase of a study of sediment issues and program review in the Province of Ontario. Conservation Management Systems was retained to undertake the study in response to a wish of Environment Canada, Ontario Region, and the Sediment Survey Section of the Water Resources Branch to acquire a better understanding of the role and importance of sediment data in Ontario. Phase I of the study has focused attention on the identification of existing uses of sediment data, evaluation of the data base, and clarification of issues associated with sediment. The second phase to be undertaken commencing in April 1985, has been planned to assess the state of knowledge regarding sediment and to identify future data needs and approaches to meet those needs. The results emanating from the two phases of this study, when assembled with results from similar studies being undertaken in four other regions of the country (i.e. British Columbia and the Yukon, the Prairies, Quebec, and the Maritimes), are intended to provide a base for the establishment of a national perspective on sediment issues.

Relevance of the Study

It seemed evident at the outset of this study, but has become increasingly clear during Phase I, that the exercise of reviewing the sediment program in Ontario is particularly relevant at this time. The existing data base has been assembled now for upwards of 20 years, a sufficiently long period of record to allow useful analysis and examination of questions such as: What have we learned? Where now? Much has already been done with sediment data in the last few years (e.g. as input to local reservoir and harbour studies, and to regional water quality projects undertaken under the auspices of groups such as the Pollution from Land Use Activities Reference Group, the Grand River Implementation Committee, and the Thames River Implementation Committee), leading to the development of both temporal and spatial pictures of sediment generation and transport. In light of such work, it is appropriate to ask: Where now are the gaps in our information and knowledge?

It has also become evident that whereas sediment data was used 20 years ago primarily for sediment volume related studies, the data is now being examined extremely with regard to quality oriented issues. Further, it is evident that the users of the data are no longer solely engineers but also biologists, agrologists, geographers, farmers, etc. Therefore, it is indeed timely and important to review the issues, users, and uses associated with sediment in the province, and to resolve the questions: Do present sediment data meet our needs? How should sediment programs be modified to insure that most future needs can be addressed?

CONSERVATION MANAGEMENT SYSTEMS
Sediment Issues and Data Needs in Ontario, Executive Summary, 17 p., 1986.

EXECUTIVE SUMMARY

In response to a need expressed by Environment Canada, Conservation Management Systems has undertaken a thorough study of sediment issues and programs in Ontario. This study has involved the use of a questionnaire and interviews with a cross section of sediment data users and collectors in the province. a one-day workshop with representatives from many of the sediment data user groups, and an extensive literature review regarding knowledge gleaned from Ontario sediment data. Results from this multifaceted approach to the topic have been combined, organized, and discussed under the headings of: sediment issues. sediment knowledge, and sediment data. The study has led to a clarification of issues relating to sediment, an assessment of knowledge regarding sediment in Ontario, and the identification of needs and recommendations regarding the data base, sampling strategies and methods, and the sediment information system.

CONSERVATION MANAGEMENT SYSTEMS
Sediment Issues and Data Needs in Ontario, Final Report, 135 p., 1986.

ABSTRACT

This report presents results obtained from a study of sediment issues and programs in Ontario and is one of several reviews across Canada to establish a national perspective on sediment issues and related program needs for Environment Canada. The Ontario study involved the use of a questionnaire and interviews with a cross section of sediment data users and collectors in the province, a one-day workshop of data users, and an extensive literature review. Results are combined, organized and discussed under the heading of sediment issues, knowledge, data and information systems. The report identifies needs and makes recommendations regarding the data base, sampling strategies and methods, and the sediment information system.

NOTE: A French translation of the text of this report is available upon request.

RÉSUMÉ

La présent rapport renferme les résultats d'une étude sur des questions et des programmes relatifs aux sédiments en Ontario. Il s'agit de l'une des nombreuses études menées au Canada pour se doter d'une perspective nationale sur les questions relatives aux sédiments et sur les besoins connexes des programmes d'Environnement Canada. En Ontario, on s'est servi d'un questionnaire et on a mené des entretiens avec un transect d'utilisateurs de données et d'échantillonneurs partout dans la province. On a donné un atelier d'un jour pour les utilisateurs de données et on a fait une revue de littérature exhaustive. Les résultats ont ensuite été compilés, organisés et discutés sous différentes rubriques : questions relatives aux sédiments, connaissances, données et systèmes d'information. Le rapport signale des besoins et renferme des recommandations relativement à la base de données, les stratégies d'échantillonnage et les méthodes connexes, et le système d'information sur les sédiments.

NOTE : On peut obtenir sur demande la version française du cette rapport.

DAY, T.J.

"Evaluation of Long Term Suspended Sediment Records for Selected Canadian Rivers", in Sediment Budgets (Proceedings of the Porto Alegre Symposium, December 1988), IAHS Publ. no. 17?, p. 101-107, 1988.

ABSTRACT

Long term suspended sediment monitoring in Canadian rivers began in the 1950s for purposes which included documentation of geophysical processes and reservoir sedimentation. Many detailed (50-200 samples/year) data records with lengths of 10-30 years now exist. Presently both economic concerns and an awareness of different environmental applications have prompted a review of these records. Results indicate, for example, that mean characteristics are stable after about 10 years, and that a good range of conditions has been sampled. As a consequence of these reviews the emphasis of Canadian sediment monitoring activities is shifting towards shorter term programmes with reduced number of samples.

RÉSUMÉ

La surveillance à long terme des sédiments en suspension dans les cours d'eau canadiens a débuté durant les années 1950 pour satisfaire divers besoins dont la documentation des processus géophysiques et de la sédimentation des réservoirs. Il existe maintenant de nombreux enregistrements détaillés de données (de 50 à 200 échantillons par an) effectués pour des périodes allant de 10 à 30 ans. Toutefois, des préoccupations d'ordre économique et une sensibilisation aux différentes applications environnementales des données ont incité le Ministère à examiner ces enregistrements. L'examen démontre par exemple que les caractéristiques moyennes sont stables aprés 10 ans environ et qu'on a échantillonné un choix assez vaste de conditions. A la suite de cet examen, le Canada a décidé de réorienter ses activités de surveillance des sédiments pour réaliser de programmes d'études à court term où les prélèvements d'échantillons seraient en nombre réduit.

DAY, T.J.

Executive Summaries for Sediment Issues Contracts, 81 p., 1986.

FOREWORD

This report presents the Executive Summaries for each of the five sediment issue reports prepared under contract for the Sediment Survey Section, Water Resources Branch of Inland Waters Directorate. All reports are in final form.

Prefacing the Executive Summaries are notes prepared for Inland Waters Directorate meetings during which the issue reports were discussed. These notes will provide insight into the Sediment Survey Section's initial assessment and reaction to the issue reports. A copy of the existing mandate for the Sediment Survey Program is also included.

DAY, T.J.

Sediment Surveys: It's Time to Yield, 40 p., 1986.

INTRODUCTION

Recent program evaluations have indicated that the Sediment Survey Program of Water Resources Branch must be rationalized and diversified in order to meet the needs of Canadian water resource managers for data, expertise and information.

While sediment is of interest to many Canadian agencies, not one of these appears to have sufficient expertise to address its own concerns, much less provide focus and leadership on a national scale. The proposed new Sediment Survey Program goes beyond mere data collection to give this focus and leadership for sediment and sediment-related concerns in Canada's inland waters.

The proposed changes in the program will result in a network that will continue to be approximately 1/10 of the existing hydrometric network. It will be very specialized, as many aspects of sediment source, transfer and fate (e.g., chemistry, navigation, environmental impacts) must be considered. The program must also pursue its responsibilities to its clients and users aggressively and proactively.

DAY, T.J.

WNR Sediment Survey Program: Issues, Network and Recommendations, 45 p., 1986.

INTRODUCTION

The Terms of Reference for the hydrometric network evaluation and planning activities, Appendix I, stated the objectives are to (1) define the adjustments to existing networks and (2) identify additional requirements for streamflow, water level and sediment information in the Western and Northern Region (W&NR).

Initial emphasis was to be given to a definition of the federal responsibility requirements and an evaluation of how well the existing network met those requirements. In addition, the joint federal-provincial and provincial information requirements were to be defined and compared to the ability of existing network to provide that information. Two planning horizons were to be used: 1985 as a definition of present requirements, and 1990 as the near-term future requirements.

As the essence of this review exercise was the establishment of information requirements in W&NR, the evaluation of 'sediment aspects' was based upon the Sediment Survey Program rather than networks only. This distinction is important as this program is delivered through both a 'network' of data collection stations and of studies (e.g. morphological, sediment budgets, relation to ecosystems and water quality).

The information summarized herein was obtained from several sources. First, a questionnaire (Appendix II) was distributed to federal and provincial agencies and a few key individuals (e.g. universities, consulting firms). The questionnaire covered problems, activities, data, information requirements and the guidance required from the Water Resources Branch. Further sources of information were previous program evaluation reports, both regional and national, and from a range of reports which contain either single station or regional data evaluations. Finally, Water Survey of Canada files on data collection programs were used to compile various summary information.

Unfortunately, certain gaps and weaknesses in this information prevented a thorough assessment of the existing program and future needs. Consequently, the Terms of Reference can be met in only a general way. It has been possible only to develop a new sense of direction for the program.

DAY, T.J. and SPITZER, M.O.
Sediment Station Analysis: Highwood River near the Mouth, 05BL024, 197 p., 1985.

ABSTRACT

Sediment data were collected at the hydrometric gauging station site, Highwood River near the Mouth, during the period 1970 to 1981 inclusive. The report deals primarily with suspended sediment, but includes information on bed material as well. This report documents the collected data and treats it in various tabular, graphical and statistical ways. It also contains a basin description and photographs taken in the immediate vicinity of the gauging station.

RÉSUMÉ

Les données sur les sédiments ont été relevées à l'emplacement de la station de jaugeage hydrométrique, Highwood River near the Mouth, pendant la période de 1970 à 1981 inclusivement. Les données concernent principalement les relevés de sédiment en suspension; dans certains cas, des informations sur le charriage de fond peuvent être incluses. Ce présent rapport fournit la documentation au sujet des données sous forme de graphiques, de tableaux, et de statistiques. Il y aussi une description du bassin hydrographique, et des photos de l'emplacement de la station.

DEVEAU, J-G.
Atlantic Region Sediment Action Plan - The Next Three Years and Beyond, 16 p., 1988.

ABSTRACT

The Atlantic Region Sediment Action Plan will serve as a guide for the management and operation of the Water Resources Branch sediment programme in the four Atlantic Provinces for the next three years. It gives an overview of the current sediment monitoring situation and provides a time frame for achieving limited changes to bring the existing practices more in line with the recently approved sediment national action plan.

To produce this document, recommendations from the Washburn & Gillis report "Freshwater Sediment Data Collection and Use in the Atlantic Region" and "Proceedings of Charlottetown Sediment Issues Workshop" were utilized, but only to the limit they meshed with the sediment national action plan and were compatible with available resources.

The implementation of several of the recommendations will depend on a large extend on outside factors such as co-operation with the provinces and interest in sediment issues from their part.

RÉSUMÉ

Le plan de travail sédimentologique de la Région de l'Atlantique va servir de guide aux gestionnaires et opérateurs du programme sédimentologique de la Direction des ressources en eau dans les quatre provinces de l'Atlantique. Il donne un apperçu de la situation actuelle en terme d'échantillonage des sédiments et fourni un échéancier pour implanter certains changements afin d'aligner les pratiques courantes avec celles véhiculées dans le plan de travail sédimentologique national récemment approuvé.

Ce document utilise des recommendations des rapports Washburn & Gilles "Freshwater Sediment Data Collection and Use in the Atlantic Region" et "Proceedings of Charlottetown Sediment Issues Workshop" mais seulement en autant que celles-ci soient compatibles avec le plan de travail sédimentologique national et les ressources disponibles.

La mise en oeuvre de plusieurs des recommendations va dépendre en gros sur des facteurs externes tels la collaboration des provinces et l'intérêt qu'elles porteront aux questions sédimentologiques.

DOLAN, E.

An Evaluation of the Vacuum Filtration Technique with respect to a Range of Vacuum Levels, 30 p. plus appendix.

SUMMARY

This report provides an evaluation of the vacuum filtration technique with respect to a range of vacuum levels. Results showed that the bottom withdrawal analysis of representative samples from the concentration ranges greater than 500 parts per million indicated that relatively uniform samples were produced for testing. The investigation of the weight loss in the filtrate demonstrated that the loss in the sediment values was due to soluble material in the bed material sample used to prepare the test samples. The sediment and hence the concentration values remained consistent taking this into account. Thus, the range of vacuum levels had no effect on the vacuum filtration technique.

DOLAN, E.F. and CASHMAN, M.A.

Evaluation of Lyophilization Method of Disaggregating Sand, Silt and Clay, 35 p., 1978.

ABSTRACT

The Sediment Survey program includes the collection of "bed material" samples that are analyzed for particle size distribution. The present method of oven-drying requires vigorous grinding with a mortar and pestle to disaggregate the particles. The adaptation of the freeze dryer reduces this grinding time considerably.

This report evaluates the freeze dryer or lyophilization method of disaggregating sands, silts and clays for particle size analysis and compares it with the oven-dried method presently used in the Sediment Laboratories of the Water Survey of Canada.

RÉSUMÉ

Le programme d'études des sédiments consiste à prélever des échantillons de "matériaux de fond" pour en faire l'analyse granulométrique. La méthode actuelle de séchage au four exige que le matériau soit d'abord vigoureusement broyé dans un mortier afin de le désagréger. La nouvelle méthode de séchage à très basse température réduit considérablement le temps passé à le broyer.

Dans le présent rapport, on évalue la méthode de séchage à très basse température ou lyophilisation, employée pour désagréger les sables, les limons et les argiles destinés à l'analyse granulométrique, par rapport à la méthode de séchage au four actuellement utilisée dans les laboratoires d'études des sediments de la Division des relevés hydrologiques du Canada.

DURETTE, Y.J.
A Capacity Study of Reid Lake, 21 p., 1981.

SUMMARY

The planning of a morphological study of Reid Lake, also known as Duncairn Reservoir, was initiated in 1973 by the Water Survey of Canada Division, Western and Northern Region and Ottawa offices. This study was part of a larger project aimed at conducting morphological surveys on a selected number of reservoirs in the Qu'Appelle Valley. This report briefly describes the instrumentation and methods used in the data collection, reduction and analysis of the hydrographic survey of Reid Lake conducted in 1975 and 1976. The measured yearly sedimentation rate was 38.8 dam^3, with an estimated life of the reservoir in the order of 1300 years.

DURETTE, Y.J.

Data Report Lake of the Prairies 1973 Morphological Survey, 10 p. plus figures and tables, 1976.

SUMMARY

A morphological survey of the Lake of the Prairies on the Assiniboine River, Manitoba, was undertaken following a request by the Manitoba Department of Mines and Natural Resources, Water Control and Conservation Branch. The survey, conducted from August 29 to September 5, 1973, was a joint project between the Ottawa and Winnipeg offices. This report describes the instrumentation and methods used in the data collection and editing procedures. It presents a data summary. A preliminary study of the data indicates that the sectors surveyed should be efficient and representative indicators of the sedimentation processes active within the main body of Lake of the Prairies.

DURETTE, Y.J.
Instructions for Collecting Daily Suspended Sediment Samples, 5 p., 1968.

SUMMARY

This guide provides observers with step-by-step procedures for collecting daily suspended sediment samples. When using these instructions the observer should keep in mind that they are only a guide; it could be possible to follow these procedures literally for many stations, while they could also be impractical at some others.

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DURETTE, Y.J. and ZRYMIAK, P.

HYDAC-100--An Automated System for Hydrographic Data Acquisition and Analysis, 44 p., 1978.

ABSTRACT

In recent years there has been an increasing demand for more complete and accurate information on hydrological and geomorphological processes in Canadian waters. Obtaining this type of information requires collection of massive amounts of data, rapid edition of all data and careful analysis of the results.

To cope with these demands, the Sediment Survey Section of the Applied Hydrology Division has developed an automated high-speed data collection and processing system (HYDAC-100) and a computerized data reduction and analysis system (HYDRA).

This paper provides information on the development and description of the HYDAC-100 system, a description of the survey methods to which the HYDAC system may be applied, the typical HYDAC-100 survey procedure, the development and description of the HYDRA system and an outline of possible future developments.

RÉSUMÉ

Au cours des dernières années, la demand d'informations complètes et exacts sur les processus hydrologiques et géomporphologiques de cours d'eau canadiens a accusé une hausse sensible. L'obtention des telles informations se fonde sur l'emmagasinage d'un grand nombre de données, le traitement rapide des données recueillies et l'analyse rigoureuse des résultats obtenus.

C'est en réponse à la demande que la Section de l'étude des sédiments, Division de l'hydrologie appliquée, a élaboré un système automatisé rapide d'emmagasinage et de traitement des données (HYDAC-100) ainsi qu'un système HYDAC peut s'appliquer, sur la méthode d'étude auxquelles le système HYDAC peut s'appliquer, sur la méthode d'étude type de l'HYDAC-100, sur l'élaboration et la description du système HYDRA de même que sur les possibilités d'applications futures.

DURETTE, Y.J. and ZRYMIAK, P.
HYDAC-100 Development-Description-Application and Data Analysis, 44 p., 1978.

SUMMARY

An electronic data collecting system HYDAC-100 has been developed by the Sediment Survey Section of the Applied Hydrology Division, Environment Canada, to facilitate the collection, reduction and analysis of data required to study sedimentation rates and distributions in rivers, reservoirs, and estuaries. The data collection system is comprised of two dynamic distance measuring devices, an echo-sounder/digitizer, a precision electronic digital clock, a data coupler, a magnetic tape recorder, a line printer, a programmable calculator, and a plotter. The system is coupled with a series of computer programs to process and analyse the data and has been instrumental in keeping up wit the increasing demand for studies on hydrological and geomorphological processes in Canadian waters without an increase in personnel.

The evolution of the HYDAC-100 and the HYDRA systems from their first introduction in 1973 have proven to be valuable assets to the Sediment Survey program. A number of geomorphological studies which were practically impossible without quick and efficient data collection and analysis are now being carried out by the Sediment Survey Section. Also systems of this nature have demonstrated a potential for efficient collation of data used as input to mathematical models and to provide data for studies such as the determination of bed load transport through the measurement of migrating dunes.

Other advantages of the HYDAC-100 are that the system can be transferred to any vessel capable of powering and housing it. It can also be operated in shallow, fast flowing water at high survey speed by few personnel. Previously a crew of eight was required to conduct a conventional survey while now a much more comprehensive and accurate survey can be conducted in less than half the time with a quarter of the staff and at a lower cost.

ENGEL, P.

Characteristics of the WSC Basket Type Bed Load Sampler, 19 p. plus tables and figures, 1982.

SUMMARY

Using dimensional analysis, the sampler catch and sampling efficiency of the WSC basket type bed load sampler were expressed in terms of flow condition, sediment properties and sampler geometry. Existing data and new data obtained in a large sediment flume, using pertinent independent variables. The sampler catch was found to increase with the sampling time t_*U_*/L_b (t_* = sampling time, U_* = shear velocity, L_b = length of the sampler), with the mobility number $\rho U_{*2}/\gamma_{sD50}$ (ρ = density of water, γ_s = submerged unit weight of sediment), the relative grain size D_{50}/L_a and the grain size distribution factor ψ ($\psi = D_{84}/D_{16}$). The sampling efficiency was found to depend on t_*U_*/L_b and D_{50}/L_a. When $D_{50}/L_a > 0.048$, the sampling efficiency was found to depend on t_*U_*/L_b only. For practical application, a sampling efficiency of 30% may be used when $30 \leq t_*U_*/L_b \leq 90$.

RÉSUMÉ

On a utilisé l'analyse dimensionnelle pour exprimer le volume de prise et le rendement de l'échantillonneur de charge de fond in forme de panier de la D.R.H.C. en fonction des conditions d'écoulement, des propriétés des sédiments et de la géométrie de l'échantillonneur. Des données existantes et de nouvelles données recueillies dan un grand bassin sédimentologique à l'aide de maquettes et l'échantillonneur ont permis d'étudier les effets des variables indépendantes pertinentes t_*U_*/L_b (t_* = temps d'échantillonneur, du facteur de mobilité $\rho U_{*U2}/T_sD_{50}$ (ρ = masse volumique de l'eau, T_s = masse volumique immergée des sédiments), du diamètre relatif des grains D_{50}/L_a et du facteur de répartition granulomêtrique ψ ($\psi = D_{84}/D_{16}$). Le rendement d'échantillonnage est fonction de t_*U_*/L_b et de D_{50}/L_a. Lorsque $D_{50}/L_a > 0{,}0048$, le rendement est fonction de t_*U_*/L_b seulement. En pratique, on peut estimer à 30% le rendement lorsque $30 \leq t_*U_*/L_b \leq 90$.

ENGEL, P.

Critical Mean Velocity for Open Channel Flow over Coarse Bed Material, 36 p., 1983.

SUMMARY

Using dimensional analysis it was shown that the dimensionless critical mean flow velocity is a function only of the relative flow depth when the flow is fully rough turbulent. This made it possible to develop a theoretical equation for the critical flow velocity using the Karman-Prandtl logarithmic velocity distribution. Comparison of this equation with those proposed by others showed that it gave the most reliable estimates of critical flow velocity for all depth to grain size ratios greater than 10. The equation was used to develop a critical velocity diagram which can be used to determine the competent flow velocity when the specific gravity of the bed material is 2.7 which is approximately the value for most river gravels and coarse sands.

RÉSUMÉ

En faisant appel à l'analyse dimensionnelle, on a démontré que la vitesse moyenne critique d'écoulement, exprimée sans dimension, n'est fonction que de la profondeur relative d'écoulement, lorsque l'écoulement est particulièrement turbulent. On est aussi parvenu à élaborer une équation théorique de la vitesse critique d'écoulement, en employant la distribution logarithmique de la vitesse selon Karman-Prandtl. En comparant cette équation à d'autres proposées, on a vu qu'elle donnait l'estimation la plus fiable de cette vitesse critique à toutes les profondeurs, jusqu'à des rapports granulométriques supérieurs à 10. On a employé cette équation pour établir un diagramme de la vitesse critique qui permette de déterminer la vitesse d'écoulement compétente, lorsque la densité des matériaux du lit est 2,7, soit approximativement la valeur caractérisant la plupart des graviers et sables grossiers fluviatiles.

ENGEL, P.

Performance Characteristics of the VUV Bed Load Sampler, 20 p., 1983.

SUMMARY

Dimensional analysis was used to express the sampler catch and sampling efficiency of the VUV type bed load sampler in terms of flow condition, sediment properties and sampler geometry. Existing data and new data obtained in a large sediment flume, using a scale model of the half size VUV sampler, were used to examine the effects of the pertinent independent variables. The sampler catch was found to depend on four dimensionless variables whereas the sampling efficiency could be defined in terms of one dimensionless variable. The sampling efficiency was found to vary from 60% to about 30% over the normal operating range.

RÉSUMÉ

L'auteur s'est servi de l'analyse dimensionnelle pour exprimer le prélèvement de l'échantillonneur et le degré d'efficacité de l'échantillonneur de débit solide du type VUV du point de vue de l'écoulement, des propriétés des matières en suspension et de la forme de l'échantillonneur. Pour observer les effets des variables indépendantes qui s'appliquent dans ce cas, il a utilisé les données existantes ainsi que de nouvelles données obtenues dans un grand canal d'essai au moyen d'un modèle réduit de l'échantillonneur VUV demi-taille. L'auteur a constaté que le prélèvement de l'échantillonneur obéissait à quatre variables sans dimension, tandis que l'efficacité de l'échantillonnage pouvait être définie d'après une variable sans dimension. L'efficacité de l'échantillonnage a varié de 60% à environ 30% de plus que l'intervalle de fonctionnement normal.

ENGEL, P.

Sampling Efficiency of the VUV Bedload Sampler, 21 p., 1983.

SUMMARY

Using dimensional analysis, the sampling efficiency of the VUV type bedload sampler was expressed in terms of flow condition, sediment properties, sampler geometry and sampling time. Existing data and new data obtained in a large sediment flume, using scale models of the sampler, were used to develop a calibration curve for this type of sampler. The data showed that the sampling efficiency decreases with the increase in the dimensionless trap number $t_* U_* / L_c$ (t_* = sampling time, U_* = shear velocity and L_c = width of the sampler intake). Comparison of calibration curves for the VUV and WSC basket sampler showed that the shapes of the curves are similar, however, the sampling efficiency of the VUV sampler is always higher. Further tests are required to assess the effect of grain size on the sampling efficiency.

RÉSUMÉ

Au moyen de l'analyse dimensionnelle on exprime l'efficacité de l'échantillonneur de débit solide de type VUV en termes de l'écoulement, des propriétés des matières en suspension, de la forme de l'échantillonneur et de la durée de l'échantillonnage. On a utilisé les données existantes et de nouvelles données obtenues dans un grand canal d'essai au moyen de maquettes à l'échelle de l'échantillonneur afin de mettre au point une courbe d'étalonnage pour ce type d'échantillonneur. Les données ont démontré que l'efficacité de l'échantillonnage diminue en fonction de l'augmentation du coefficient sans dimension de fosse $t_* U_* / L_c$ ($_*$ = durée de l'échantillonnage, U_* = vitesse de frottement et L_c = largeur de l'orifice d'admission de l'échantillonneur). La comparison des courbes d'étallonnage des échantillonneurs VUV et WSC à panier a montré que les courbes sont analogues; toutefois l'échantillonneur VUV s'avère toujours d'une efficacité supérieure. D'autres essais sont nécessaires afin d'évaluer l'influence de la granulométrie sur l'efficacité de l'échantillonnage.

ENGEL, P. and LAU, Y.L.
Efficiency of Basket Type Bed Load Samplers, 16 p., 1980.

ABSTRACT

Experiments were conducted in a sediment flume using three models of a basket sampler to determine their sampling efficiency. The results, together with analysis of data from the literature, indicate that the sampling efficiency of basket samplers is not constant but may be a function of two dimensionless variables.

RÉSUMÉ

Afin de déterminer l'efficacité de trois modèles d'échantillonneurs de type panier, on s'en est servi pour faire des expériences dans un canal d'amenée des sédiments. Les résultats, ajoutés à l'analysée des données que fournir la documentation, indiquent que le rendement des échantillonneurs du type panier n'est pas constant. Il dépend de deux variables sans dimension.

ENGEL, P. and LAU, Y.L.
Preliminary Considerations for the Calibration of Bed-Load Samplers, 29 p., 1979.

SUMMARY

A brief review of bed-load sampler calibrations was made to determine a plan for the calibration of samplers for Water Survey of Canada. Basic analytical considerations revealed that a calibration equation for a given sampler might contain four independent dimensionless variables and the effects of each must be determined experimentally. Limited data from calibration of a WSC basket sampler has shown that there is a strong likelyhood that the sampling efficiency of a bed-load sampler may be determined by a single dimensionless parameter called the TRAP NUMBER. The form of the general calibration equation suggests that it may be desirable to review field sampling procedures. Recommendations are made to conduct tests to determine the relative importance of the independent variables in the general calibration equation for different sets of conditions.

SOMMAIRE

On a effectué une étude rapide des étalonnages de l'échantillonneur de charriage de fond pour fixer un plan en vue de l'étalonnage des échantillonneurs pour la Division des relevés hydrologiques du Canada. Les considérations analytiques fondamentales one rélévé qu'une équation d'étalonnage pour un échantillonneur donné peut contenir quatre variables indépendantes sans dimension. Il faut déterminer les effets de chacune de ces variables, de façon expérimentale. Les données limitées provenent de l'étalonnage d'un échantillonneur en forme de panier de la Division des relevés hydrologiques du Canada on démontré qu'il est fort possible de pouvoir connaître l'efficacité d'échantillonnage d'un échantillonneur de charriage de fond grâce à un paramètre unique sans dimension appelé COEFFICIENT DE PIÉGEAGE DES SEDIMENTS. La forme de l'équation générales d'étalonnage révèle qu'il peut être souhaitable d'étudier les modelités pratiques d'échantillonnage. On a soumis des recommendations en vue d'assuis pour connaître l'importance relative des variables indépendantes de l'équation générale d'étalonnage dans diverses conditions.

ENGEL, P. and WIEBE, K.
A Hydrographic Method for Bed-Load Measurement, 16 p., 1979.

SYNOPSIS

A simple equation has been developed for use with river-bed profile data obtained with the HYDAC-200 hydrographic survey system, to compute bed-load discharge in alluvial rivers. The equation was tested with experimental data obtained in a sediment flume and compared with the Ackers-White total-load formula. The HYDAC-200 survey system was described and its application to the Fraser River at Mission, British Columbia, discussed.

RÉSUMÉ

Une équation simple a été établie en vue d'être utilisée avec les données sur le profil du lit d'un cours d'eau obtenues au moyen du système de levés hydrographiques HYDRAC-200, afin de calculer le débit charrié dans des cours d'eau alluviaux. L'équation a été mise à l'épreuve avec les données obtenues grâce aux expériences menées dans un canal sur appuis avec sédiments et comparée à la formule Ackers-White de charge totale. Le système de levés HYDRAC-200 a été décrit et son application au Fraser, à Mission, en Colombie-Britannique, a été étudiée.

ENGEL, P. and ZRYMIAK, P.
Development of a Calibration Strategy for Suspended Sediment Samplers - Phase I, 23 p., 1989.

ABSTRACT

Using dimensional analysis, basic equations were developed as a basis to formulate a suspended-sediment sampler calibration strategy. The equations were applied to review the calibration method used by the Water Survey of Canada prior to 1972. A research program is proposed to provide the necessary information to establish an updated calibration strategy.

RÉSUMÉ

Des équations de base ont été créées à l'aide de l'analyse dimensionnelle pour mettre au point une stratégie d'étalonnage des appareils d'échantillonnage de sédiments en suspension. Ces équations ont été utilisées pour réviser les méthodes d'étalonnage employées par la Division des relevés hydrologiques du Canada avant 1972. Un programme de recherche visant à fournir les informations nécessaires à l'établissement d'une stratégie d'étalonnage modernisée est proposé.

FRENETTE, M., BARBEAU, C., and VERRETTE, J.-Ls.
Aspects quantitatifs, dynamiques et qualitatifs des sédiments du Saint-Laurent, 185 p., 1989.

RÉSUMÉ

Le présent document constitue une compilation et une mise à jour des données disponibles sur les sédiments du Saint-Laurent, intégrées et analysées sous trois thèmes différents: aspects quantitatifs, dynamiques et qualitatifs. Des recherches particulières et une modélisation mathématique ont également servi de support à plusieurs énoncés du contenu. Les données sont fournies selon divers modes de présentation puis synthétisées dans huit planches caractérisant les principaux traits dominants du fleuve sur le plan sédimentologique. L'information contenue dans ce document facilitera l'évaluation environnementale et le programme de protection et de mise en valeur du Saint-Laurent.

ABSTRACT

This report is a compilation of the available data on the sediments of the St. Lawrence River, integrated and analysed under three different themes: quantitative, dynamic and qualitative aspects. Particular researches and mathematical modelling have provided support for several statements. The data are presented in various formats and synthesized in eight general drafts characterizing the main features of the St. Lawrence in regard to the sedimentological aspects. The information contained in the report shall help the environmental evaluation and the programme of protection and of development of the St. Lawrence River.

GILLILAND, J.A, DICK, T.M., BRIMLEY, W., and CAMPBELL, P.I.
IWD Sediment Quantity Surveys and Studies, 24 p. plus appendices, 1979.

SUMMARY

This report presents the policy decisions and report of a Task Force on Sediment Surveys, as well as the decisions of the Directors of the Inland Waters Directorate (IWD) relating to the Water Resources Branch sediment survey program. The report provides the rationale for Water Resources Branch involvement in such surveys. The Federal and IWD responsibilities, IWD roles, priorities, cost sharing and cost recovery, and recommendations are outlined.

GLAVIC, H., DAY, T.J., and YUZYK, T.R.
Interpretation of Suspended Sediment Characteristics, Red River at Emerson, Manitoba, 1978-1986, 66 p., 1988.

ABSTRACT

There is a growing awareness that fine suspended sediments are a prime media for the transport and storage of many contaminants. Within the Inland Waters Directorate. Water Quality and Water Resources Branches have responsibilities for monitoring contaminants and suspended sediments respectively. This report, which provides a summary and interpretation of existing suspended sediment data, is the first of several planned for the Red River at Emerson, Manitoba. Sampling strategies, methodologies, equipment, computational procedures and data have been evaluated with the objective of determining how the two Branches can work more effectively together.

Meaningful suspended sediment monitoring at Emerson, Manitoba on the Red River began in 1978 with both Water Survey of Canada (WSC) and the United States Geological Survey (USGS) initiating sampling programs. The WSC program provides data on a flow-weighted basis, year round, while the USGS program collects monthly samples only. Earlier, Prairie Farm Rehabilitation Administration sampled suspended sediments during open water in 1956 and 1961.

Based upon WSC data, the mean annual suspended sediment load is 886 000 tonnes for the period 1978-1986, when the mean annual flow was 39.5% higher than the historical average. The annual distribution of load is not typical as 40% of the suspended load is transported during the June to August period. A general counter-clockwise hysteresis exists in the concentration-discharge which arises from the high summer concentrations.

Suspended sediments are silt and clay which result in quite homogeneous concentrations and particle sizes in the measurement cross sections. The bed and bank materials are of similar composition.

Finally, data collected by WSC and USGS are shown to be quite compatible and that the two data sets can be used interchangeably. Recommendations regarding the sampling program are put forth which will aid subsequent analyses.

RÉSUMÉ

Aussi disponible en français.

HANSON, D.G. and DRENNAN, L.
Portage Reservoir Sedimentation Study 1971, 10 p. plus tables and figures, 1980.

ABSTRACT

This report describes the 1971 sediment survey of the Assiniboine River Reservoir near Portage la Prairie, Manitoba. This survey was the first in a series of proposed surveys to determine the rate of capacity loss due to sedimentation in the reservoir. This study was also essential in providing geomorphic data for the effective operation of the reservoir and its associated diversion channel.

During the survey, 30 sediment ranges were established and profiled. Suspended sediment samples were collected for selected ranges and bed material samples were collected from all ranges. The survey results are illustrated by tables and graphs.

RÉSUMÉ

Ce rapport décrit l'étude des sédiments entreprise en 1971 dans le réservoir de la rivière Assiniboine, près de Portage-la-Prairie, Manitoba. Cette étude était la première d'une série d'au moins trois études qui visent à déterminer le taux de perte de la capacité du réservoir dû à la sédimentation. Il a fallu entreprendre cette étude pour pouvoir recueillir des données géomorphiques permettant d'exploiter efficacement le réservoir et son canal dérivation.

Au cours de l'étude, on a défini trente zones sédimentaires et l'on a établi un plan en coupe. On a recueilli des échantillons de sédiments en suspension dans certaines zones et l'on a prélevé des échantillons des dépôts de fond dans toutes les zones. Des tableaux et graphiques illustrent les résultats obtenus.

HARDY BBT LIMITED
Sediment Station Analysis: South Saskatchewan River at Saskatoon 05HG001, 92 p., 1989.

ABSTRACT

This is one of a series of sediment station analysis reports issued by the Water Resources Branch of Environment Canada. The report was prepared by Hardy BBT Limited under contract to the Department of Supply and Services. It presents a summary and analysis of the sediment data for the South Saskatchewan River at Saskatoon, Saskatchewan (Sta. 05HG001, for the period 1961 - 1971, and 1975). The data have also been assessed in terms of the impacts of the Gardiner Dam, channel morphology and effects on Codette Reservoir sedimentation.

Notwithstanding the general reduction in sediment loads resulting from the operation of Gardiner Dam, the data base indicates that substantial suspended sediment loads can be transported past Saskatoon. This may affect the projected life expectancies for Codette Reservoir and Tobin Lake.

It has been concluded that the available sediment data on the South Saskatchewan River at Saskatoon sufficiently describe the annual and monthly sediment regime. However, the data base appears to be deficient in fully describing the flow regimes for higher flows, and especially the trap efficiency of Gardiner Dam.

It is recommended that the sediment data collection program on the South Saskatchewan River at Saskatoon be re-established on a special event basis to document sediment discharges for flows >1500 m^3/s. Suspended sediment particle size data should also be collected to determine the type of material being transported.

RÉSUMÉ

Aussi disponible en français.

HARDY BBT LIMITED

Sediment Transport Analysis: Lesser Slave Basin Volume 1, 42 p., 1989.

ABSTRACT

Sediment data have been collected in the Lesser Slave Lake basin since 1969. These data have been collected at six sites. The objective of the data collection program was to provide sediment data for engineering applications such as the effects of channelization, the monitoring of land use changes, and for use in the development of a management plan for the Buffalo Bay area.

This report contains a review of all the available sediment data in the basin and provides an analysis of these data with respect to their potential use. The sediment budget of Lesser Slave Lake is evaluated and the sediment issues in the basin are discussed.

The report concludes that sufficient information is available at four of the six sites and recommends these be discontinued. The report also recommends that the Swan River near Kinuso site be maintained but that the sediment program be downgraded to a partial program. However the report does recommend the establishment of a partial program station on the Lesser Slave River at the outlet of Lesser Slave Lake in order to determine the rate of littoral supply to the outlet channel.

The report has been printed in two volumes; the first volume containing a summary of the analyses performed, whereas the second volume describes the analyses in greater detail. Volume two contains a variety of figures and tables which characterize the sediment data for each of the six sediment stations.

RÉSUMÉ

Aussi disponible en français.

HARDY BBT LIMITED

Sediment Transport Analysis: Lesser Slave Basin Volume 2, 60 p., 1989.

INTRODUCTION

This is the second of two volumes of a report on the sediment transport in the Lesser Slave Lake basin.

The objectives of the study are to analyze the sediment data collected by Water Survey of Canada in the basin and to assess the sufficiency of the data base for calculating sediment transport into and out of Lesser Slave Lake. The adequacy of this data base for engineering, contaminant transport, and environmental purposes are also to be assessed.

This volume, a data report, contains a review of the sediment data available at each of the monitoring station and a characterization of the sediment regime at each station. A review of the discharge regime is also presented for each site since an understanding of the discharge regime is fundamental to understanding the sediment regime. Any deficiencies in the existing data for each site are presented, along with an assessment of the representativity of the data.

The material which follows is presented in a common format for each site, starting with a general description of the site, followed by a description of the discharge regime, then by a critical review of the sediment data collection program, a summary of the sediment loads, concentrations, and sediment size characteristics, and finally a review of the dissolved solids data.

Volume 1, the final report, synthesizes the information presented in the present volume on a regional basis and assesses the adequacy of the sediment monitoring program with regard to engineering, water quality, and environmental applications. A sediment budget of Lesser Slave Lake is also presented along with recommendations for future program activities.

HIRST, S.M., MILES, M., BLACHUT, S.P., GOULET, L.A., and TAYLOR, R.E.
Quantitative Synthesis of the Mackenzie Delta Ecosystems, 136 p., 1988.

ABSTRACT

The Mackenzie delta, Northwest Territories, has an area of some 13,000 km^2 and is the second largest delta in North America. It receives the discharge from a watershed of about 1,900,000 km^2 in extent, comprising 11 major drainage basins.

The report presents a quantitative synthesis of the ecosystems of the Mackenzie delta. The objective of the synthesis is to examine the structure and relative sensitivity of ecosystem components and processes within the Mackenzie delta, and to identify significant information gaps.

Most of the information in the synthesis is drawn from studies undertaken by B.C. Hydro from 1980 through 1983. A total of 36 B.C. Hydro source reports, 33 of which deal with the Mackenzie delta, 2 with the Beaufort Sea and 1 with socio-economic concerns, are listed in an appendix. A keyword index provides a listing of all physical and biological data contained in the source reports. Supplementary information has been taken from other recent studies and from the literature.

RÉSUMÉ

Le delta du Mackenzie, dans les Territoires du Nord-Ouest, s'entend sur une superficie de quelque 13 000 km^{2}et est le deuxième delta en importance en Amérique du Nord. Il reçoit le débit en provenance d'un bassin hydrographique d'une étendue approximative de 1 900 000 km^2 qui regroupe 11 grands bassins.

Le présent rapport fait la synthèse quantitative des écosystèmes du delta du Mackenzie. Cette synthèse vise à examiner la structure et la sensibilité relative des éléments et processus des écosystèmes présents dans le delta et d'identifier les lacunes importantes au chapitre des données.

La plupart des rensignements contenus dans cette synthèse proviennent d'études réalisés par la B.C. Hydro et 1980 à 1983. Trente-six rapports de la B.C. Hydro sont cités en annexe, soit 33 portant sur le delta du Mackenzie, 2 sur la mer de Beaufort et 1 sur des préoccupations d'ordre socio-économique. Un index de mots clés donne la liste exhaustive des données physiques et biologiques contenues dans les rapports. Des renseignements additionnées, tirés d'études récentes et d'autres documents, complètent le rapport.

HUDSON, H.R. and ASKIN, R.W.
An Interpretive Study of the Upper Oldman River Sediment Regime, 172 p., 1987.

ABSTRACT

Sediment sources and controls on suspended sediment transport are examined in the Oldman River basin above Brocket in Southwestern Alberta. The major sediment sources in the 4 400 km^2 river basin were isolated by constructing a sediment budget from existing sediment records, delimiting sediment sources using aerial photograph and site inspections, and constructing topographic maps of major erosion sites from 1965 and 1985 aerial photographs to calculate erosion losses. Additional inferences on sediment sources were gained from a comparison of particle size distributions, cesium-137 content, and petrographic variations from sediment sources, river channel deposits and sediment load at the Brocket hydrometric station. This information was combined with a description of physiography and climatology to interpret the suspended sediment regime of the Upper Oldman River basin.

The annual suspended sediment load of the Oldman River near Brocket (05AA024) is about 275 000 tonnes, with a standard error of estimate of 30 percent. The sediment budget indicated that the major suspended sediment contribution areas in the Upper Oldman River basin are, in order of importance: (1) the lower basin area of the Oldman, Castle and Crowsnest Rivers (about 190 000 t/y); (2) the Castle River foothills and mountains (40 000 t/y); (3) the Oldman River above Waldron's Corner (34 000 t/y); (4) Mill Creek (6 000 t/y); and (5) the Crowsnest River above Frank (4 000 t/y). These estimates are based on fewer data, and are less reliable than the annual load estimate at Brocket.

The sediment regime of the Oldman River near Brocket is explicable in terms of the interaction between the hydrologic response and sediment sources. Smaller magnitude annual floods are generated largely from snowmelt in the foothills and mountains. As the magnitude of the flood increases, the rainfall component tends to increase and the contributing area expands to include the plains. The largest floods occur with heavy rainfall in the spring when the ground is saturated and snowmelt runoff occurs.

The Cardston Plain area dominates the sediment yield of the Upper Oldman River basin above Brocket. Sediment is derived from gully erosion and tributary channel enlargement and incision to base level on the plains, toe erosion of large mass movement deposits which impinge upon the river channel, and general channel erosion. Erosion occurs mainly in the spring as the result of snowmelt and/or rainfall. Occasionally, in the summer during the snowmelt recession of the Oldman River, heavy rainfall may generate pulses of sediment from the plains.

Upland contributions from the mountains and foothills are limited because of the forest cover and limitations in fine sediment supply. The major sediment sources and processes in these areas are surface was of non-vegetated colluvial slopes, and channel and riparian erosion. Runoff from the barren colluvial slopes is generated largely by snowmelt over a period of days to weeks in the spring and generally coincides with the annual flood of the Upper Oldman River. Sediment contributions from channel and riparian sources occur as the result of flushing of readily erodible material at the toe of the river banks and valley walls. The

material is sediment supply limited, which accounts for the high initial sediment concentrations on the rising limb of the flood hydrograph and the decreases in concentration with subsequent hydrograph rises. Conceptual descriptions of the processes are presented to describe these relationships.

As a result of these controls, the bulk of the annual suspended sediment transport of the Upper Oldman River occurs in a short period during the annual flood. Subsequent flood peaks contribute progressively less material as the result of sediment supply exhaustion. In some cases, high sediment loads may occur following the spring flood peak as the result of largely rainfall generated floods which cause bank erosion or upland riparian erosion.

An evaluation of methodologies employed in this interpretation of the sediment regime of the Upper Oldman River basin indicates the following:

(1) Good quality sediment records are essential in any such study, preferably at several relevant locations upstream. These records should be available in the form of the report presented by Day and Spitzer (1985), "Sediment Station Analysis, Oldman River Near Brocket".

(2) Aerial photographic reconnaissance can provide a good overview of sediment sources in a drainage basin. However, field inspection revealed a number of difficulties in interpretation in this study, and in previous work. Thus, field inspection is essential in any such future studies.

(3) Detailed topographic mapping from sequential aerial photographs provides a cost effective means of quantifying point source contributions and indicates where this erosion occurs, which is essential for inferring erosion processes.

(4) The analysis of sediment attributes such as particle size distributions, cesium-137 content, and petrographic variations of sediment sources, channel deposits and sediment yield from the basin, provide support for the interpretation developed using the aforementioned approaches.

(5) The major limitation to this type of study is that erosion processes have to be inferred from various lines of evidence. The accuracy of these inferences is dependent on the experience of the observer.

HYDROCON ENGINEERING (Continental) LTD.
Sediment Station Analysis: Pembina River near Windygates 050B007, 180 p., 1987.

ABSTRACT

This is one of a series of sediment station analysis reports issued by the Water Resources Branch of Environment Canada. It presents a summary and analysis of the sediment data for the Pembina River near Windygates, Manitoba, (Sta. 05OB007), for the period 1962-1984. The data have also been assessed in terms of the use of sediment rating curves, water quality concerns, and reservoir sedimentation studies.

It has been concluded that the available sediment data on the Pembina River near Windygates sufficiently describe the present sediment regime, and that the detailed sediment data collection program should be suspended. It is recommended that a miscellaneous sediment data collection program should be suspended. It is recommended that a miscellaneous sediment data collection program be instituted, which could run in conjunction with a short-term water quality sampling program aimed at studying organic contaminant loading. The miscellaneous program should also aim to measure suspended sediment concentrations for extreme high and low flows, as well as particle sizes for low concentrations.

HYDROCON ENGINEERING (Continental) LTD.
Sediment Station Analysis: Red Deer River at Red Deer (05CC002), at Drumheller (05CE001), near Bindless (05CK004), 101 p., 1987.

ABSTRACT

The Water Resources Branch of Environment Canada has operated major sediment data collection programs on the Red Deer River, at Red Deer, at Drumheller and near Bindloss, which was established, respectively, to monitor sediment discharge for reservoir planning, to determine sediment loads due to contribution from the Badlands, and to assist in determining sediment loads into Lake Diefenbaker.

Data from all three sites, from 1966 until suspension of the detailed monitoring programs at the end of 1984, has been analysed and summarized. Based on these analyses, it has been concluded that the suspended sediment transport characteristics and sediment yield of the Red Deer River at Red Deer, at Drumheller and near Bindloss generally have been well documented by the existing data base. Further intensive data collection will not improve the overall understanding of suspended sediment transport at these sites. However, as discharges during the detailed sediment sampling period were lower than long-term mean flows, future miscellaneous data collection programs should attempt to measure loads for extreme events beyond those covered by the present data base.

This report also evaluated the suspended sediment transport regime of the Red Deer River, and identified trends and patterns in the data between the three sites. Sediment yield from the Badlands and throughout the river basin in general was discussed, and the long-term effects of Dickson Dam operation on sediment transport was examined and found to be minimal.

RÉSUMÉ

Aussi disponible en français.

HYDROQUAL CONSULTANTS INC.
Total Dissolved Solids Trends in the Saskatchewan River Basin, 110 p., 1986.

SUMMARY

The Water Resources and Water Quality Branches of Environment Canada have, over the past three decades collected total dissolved solids (TDS) data from surface waters throughout the Saskatchewan River Basin. The Water Resources Branch (WRB) collects TDS as an adjunct to their sediment monitoring program, for the purpose of calculating geochemical yield. Water Quality Branch (WQB) collects TDS samples at their fixed river monitoring stations, and at special project sites, for definition of baseline conditions and assessment of trend in concentrations.

The total database consists of 33,585 samples, which includes 9,771 samples collected by WQB and 23,814 by WRB. Data have been collected at 223 locations. Water Quality Branch has data for 180 sites, WRB for 85 sites and there are 42 sites which overlap. The database is extensive, i.e. greater than 100 samples over at least 5 years, for 64 of the 223 total sites. Thirty-one of these long-term sites are actively sampled by one or other agency. Out of a total of 57 active stations, only 5 sites are currently sampled by both agencies.

The historical database generally covers the entire basin adequately, with a few minor exceptions including the northern tributaries of the main-stem Saskatchewan River and the South Saskatchewan River downstream of the Alberta border. A large proportion of the total sites sampled, 106 of 223, are located along the east slopes of the Rocky Mountains.

The daily TDS concentration of rivers in the Saskatchewan basin can be adequately characterized by one depth integrated sample collected at mid-channel. There is no need for a multiple-vertical sampling strategy, as is required for suspended solids. This means that despite differences in sampling strategy between WRB and WQB, this factor does not need to be accounted for when combining data from both sources. However, WQB data should be multiplied by 1.055 to compensate for analytical differences. WQB estimates TDS by sum of ions, whereas WRB used a direct gravimetric technique.

The TDS record at many points in the basin is substantial, and permits powerful time series analyses. WQB data, which follows a fixed monthly schedule, is more useful in this respect than WRB data which emphasizes high flows and open-water months. The principal long-term trends in TDS concentrations across the basin relate to flow regulation on the North and South Saskatchewan Rivers, which depresses the natural winter TDS maximum, and reduces the annual variance in concentration. More subtle effects from altered land use or increased effluent loadings are not apparent on the South Saskatchewan at Highway 41, or the Red Deer River at Bindloss, but a trend of slowly increasing TDS concentration is detectable on the lower Bow River. Municipal wastes or irrigation return flow are probably responsible for this increase. Dams recently completed or under construction on the Red Deer and Oldman Rivers are expected to disrupt the annual TDS pattern in a manner similar to that experienced by the other regulated rivers in the basin.

In both the ice-cover and open-water seasons, there is a general increase in

tributary TDS concentrations from west to east, with concentrations being low in the western sub-basins, intermediate for the North Saskatchewan and Battle sub-basins and high in the eastern sub-basins draining Saskatchewan and Manitoba. The first TDS means >500 mg/L are found in prairie streams at least 100 km east of the mountains. At the opposite end of the basin, in eastern Saskatchewan, concentrations are seldom <500 mg/L and values >1000 mg/L are commonplace.

Main-stem rivers had a nearly constant mean TDS concentration across the basin, ranging between 200 and 300 mg/L, with only a subtle increase from west to east. This trend indicates that dilute mountain runoff dominates main-stem river water concentrations throughout the basin, despite the influx of ion-rich water from the tributaries. The higher main-stem concentrations in the Battle River arise because this sub-basin, and no other, is free of the influence of mountain runoff.

Geochemical loads calculated from WQB data, WRB data or all data combined usually differ by 10% or less, except in winter when under-sampling by Water Resources Branch causes inflated loading estimates. For all other seasons, or annual estimates, data from either Branch will produce reliable results. At most locations, sampling for 10 years will produce estimates of mean TDS loads with a standard error of 10-15%. Sampling beyond this limit will not improve precision of the loading estimate; unless information on changes in load through time is required.

Most of the annual TDS load is carried during the open-water season; the small proportion carried during ice-cover increases with increasing regulation of stream flow. Rates of geochemical yield are greatest for the mountain and foothill areas relative to the prairies.

HYDROTECH INC.
État de connaissance et prospectives sédimentologiques des eaux douces du Québec, 160 p., 1985.

SOMMAIRE EXECUTIF

Depuis 1968, il y a eu, au Québec, une collection importante de données sédimentologiques qui s'est intensifiée à partir de 1969, avec l'impltation d'un réseau de base sédimentologique, réparti sur plusieurs bassins de cours d'eau. A partir de 1970, le nombre de bassins jaugés diminua graduellement pour cesser d'être opérationnel depuis 1982. Parmi les raisons qui ont entraîné l'abandon des relevés, outre les facteurs coût des opérations et difficultés de prélèvements, il y a le fait que nombre de données étaient mal utilisées ou inutilisées à cause de l'absence de liens entre les programmes de relevés et les besoins des usagers.

INLAND WATERS BRANCH

Delta Formation and Sedimentation in Lake Diefenbaker Progress Report 1964-67, 31 p. plus figures. (prepared by K. Wiebe)

SYNOPSIS

In an average year, the South Saskatchewan River carries an estimated 6,000 acre-feet of sediment. With a detention storage time of many months, most, if not all of this sediment, will be deposited in the 7.6 million acre-foot, 140-mile long reservoir known as Lake Diefenbaker. Although the amount of sediment is not large enough to affect the usefulness of the reservoir in the foreseeable future, it is expected to deposit in the form of a delta extending a considerable distance into the reservoir and for a number of miles upstream. A different though related problem concerns reservoir infilling upstream. A different though related problem concerns reservoir infilling due to erosion and slumping along the 500 miles of reservoir shoreline. These problems will affect shoreline planning a development, the design and maintenance of structures and the efficient operation of the reservoir.

In consideration of these problems, some studies were undertaken by consultants several years ago. However, the problems are very complex, and it was felt that the results of these theoretical studies should be substantiated and that the studies should be expanded upon by the collection and analysis of field data over a period of years. Accordingly, in 1963, Saskatchewan implemented a program to systematically study the progress, configuration and effect of delta formation and sedimentation which will occur in Lake Diefenbaker. This program was designated IHD Project Sask-2.

The type of program that has been developed consists of a system of 38 ranges or cross-sections, which are defined by permanent markers on each bank. and which cross the reservoir and river bed, and suspended sediment and bed material samples are collected at selected locations with the aid of the Inland Waters Branch. Another important component of this project is a program of low-level, aerial photography of the upper reservoir area, particularly at low reservoir levels. Concern over the high water levels which might be attained at the upper end of the reservoir led in 1966 to the addition of a backwater curve study which provides for the collection of data to define water surface profiles for various peak flows. The overall sedimentation program requires annual range maintenance, field surveys and data collection, and office studies to process and analyze the data collected in the field and to prepare reports.

This report summarizes the work that has been undertaken on this project during the four-year period 1964 through 1967. It replaces and updates a previous unpublished report entitled "Sediment Range Programs on and Downstream of the South Saskatchewan Reservoir" dated December 22, 1966, prepared by Saskatchewan Water Resources Commission. The latter report, in a single volume. contains information for both the South Saskatchewan River sediment range program below Gardiner Dam and the program for Lake Diefenbaker. The river range program has been designated IHD Sask-1. A comprehensive report on this study has already been published.

Figures 27 to 64 of this report show profiles across the reservoir.

INLAND WATERS BRANCH

Delta Formation and Sedimentation in Lake Diefenbaker Annual Project Report 1968, 18 p. plus appendices. (prepared by K. Wiebe)

SUMMARY

This report provides a detailed summary of survey work and data collected on Lake Diefenbaker, Saskatchewan, during the year 1968. The program was designated IHD Project Sask-2.

INLAND WATERS BRANCH

Delta Formation and Sedimentation in Lake Diefenbaker Annual Project Report 1969, 18 p. plus appendices.

SUMMARY

This report provides a detailed summary of survey work and data collected on Lake Diefenbaker, Saskatchewan, during the year 1969. The program was designated IHD Project Sask-2.

INLAND WATERS BRANCH
Delta Formation and Sedimentation in Lake Diefenbaker Annual Project Report 1970, 20 p. plus appendices.

SUMMARY

This report provides a detailed summary of survey work and data collected on Lake Diefenbaker, Saskatchewan, during the year 1970. The program was designated IHD Project Sask-2.

INLAND WATERS BRANCH

Delta Formation and Sedimentation in Lake Diefenbaker Annual Project Report 1971, 22 p. plus appendices.

SUMMARY

This report provides a detailed summary of survey work and data collected on Lake Diefenbaker, Saskatchewan, during the year 1971. The program was designated IHD Project Sask-2.

(see also Water Resources Branch for later editions)

INLAND WATERS BRANCH

Sedimentation Study Conestogo Reservoir (1969), 14 p. plus appendices, 1971. (prepared by L. Drennan)

ABSTRACT

The 1969 Sediment Survey of the Conestogo Reservoir, Ontario, is described in this report.

This was the first of a series of surveys which were to be conducted at this reservoir. Forty-eight cross-sections were established within the reservoir and their profiles were surveyed. Sampling of bed material and suspended sediment was also carried out during the survey. The survey results are illustrated by tables and graphs in the Appendices of the report.

Recommendations include a plan for subsequent surveys of the reservoir. The results of these surveys should provide sufficient data to enable evaluation of the rate of sedimentation and its effect on reservoir storage.

INLAND WATERS BRANCH

A Study of Aggradation and Degradation of the South Saskatchewan River Gardiner Dam - Saskatoon - Progress Report 1964-67, 11 p. plus appendices. (prepared by K. Wiebe)

SUMMARY

This report provides a detailed summary of sediment survey work undertaken on the South Saskatchewan River downstream from Gardiner Dam for the years 1964-67. It is a report prepared under the International Hydrological Decade (IHD), as IHD Project-1.

(see also Water Resources Branch for later editions)

INLAND WATERS BRANCH

A Study of Aggradation and Degradation of the South Saskatchewan River Gardiner Dam - Saskatoon - Annual Project Report 1968, 22 p. plus appendices. (prepared by K. Wiebe)

SUMMARY

This report provides a detailed summary of sediment survey work undertaken on the South Saskatchewan River downstream from Gardiner Dam for the year 1968. It is a report prepared under the International Hydrological Decade (IHD), as IHD Project-1.

(see also Water Resources Branch for later editions)

INLAND WATERS BRANCH

A Study of Aggradation and Degradation of the South Saskatchewan River Gardiner Dam - Saskatoon - Annual Project Report 1969, 24 p. plus appendices. (prepared by K. Wiebe)

SUMMARY

This report provides a detailed summary of sediment survey work undertaken on the South Saskatchewan River downstream from Gardiner Dam for the year 1969. It is a report prepared under the International Hydrological Decade (IHD), as IHD Project-1.

(see also Water Resources Branch for later editions)

INLAND WATERS DIRECTORATE

Belwood Reservoir 1971 Sedimentation Study, 15 p. plus appendices, 1975. (prepared by L. Drennan, G. Cavanagh)

ABSTRACT

The 1971 Sediment Survey of the Belwood River, Ontario, is described in this report.

This was the first of a series of at least three surveys which are to be conducted at this reservoir. Thirty-three cross-sections were established within the reservoir and their profiles were surveyed. Sampling of bed material and suspended sediment was also carried out during the survey. The Survey results are illustrated by tables and graphs in the Appendices of the report.

Recommendations include a plan for subsequent surveys of the reservoir and an outline of methods to be utilized for determining densities of the deposited sediment. The computed density patterns and volumetric accumulation rates will form the basis for estimating sedimentation rates within all sections of the reservoir. This information should help pinpoint future problem areas thereby enabling preventive measures to be taken in some cases. Additionally the above sectional sedimentation rates will determine the overall reservoir sedimentation rate and therefore anticipated reservoir lifetime.

INLAND WATERS DIRECTORATE

Data Report Vedder River Bed Load Study 1974-1975, 16 p. plus figures, tables, and appendices, 1976. (prepared by P. Zrymiak)

SUMMARY

This report presents a summary of data collected on the Vedder River, British Columbia, in 1974 and 1975, describes the preliminary analysis and illustrates the results. The primary objective was the collection of bed load data on the six-mile section of the Vedder River extending from the Vedder Crossing bridge to the upstream end of the Vedder Canal. Continuous bed load data from this stream were required for the design of the dykes. This report concludes a series of three similar data reports summarizing annual surveys, the first of which was conducted in 1971.

(see also Sediment Survey Section, 1974, and Tywoniuk, N., 1972)

INLAND WATERS DIRECTORATE

Fanshawe Reservoir 1972 Sedimentation Study, 28 p. plus figures. (prepared by G. Cavanagh)

ABSTRACT

The 1972 Sediment Survey of the Fanshawe Reservoir is described in this report.

This was the first of a series of at least three surveys which are to be conducted at this location, the purpose of which is to compute the reservoir's sedimentation rate and hence its life expectancy. Thirty-one cross-sections were established within the reservoir and their profiles were surveyed. Sampling of bed material and suspended sediment was also carried out during the survey. The survey results are illustrated by tables and graphs in the Appendices of the report.

Recommendations include a plan for subsequent resurvey of selected reservoir ranges which will be used to determine if a complete resurvey is required and an outline of methods used to determine densities of the deposited sediment. The volumetric accumulation rates and density patterns will form the basis in determining the overall reservoir sedimentation rate and therefore anticipated reservoir life.

INLAND WATERS DIRECTORATE

Proceedings First Sediment Survey Instruction Seminar, Winnipeg, Manitoba, November 28-December 1, 1972, 19 p., 1973.

SUMMARY

Since 1961, when the continuous sediment survey program was inaugurated, the Sediment Survey Section has grown until it now includes about 150 regular sediment stations throughout Canada. Because of this growth it is becoming increasingly difficult to obtain satisfactory results at all stations. The Winnipeg seminar is one attempt to address this. Attention was paid to automatic pumping samplers, the Canadian and American programs, and morphological surveys.

INLAND WATERS DIRECTORATE

Rationale for Involvement Sediment Related Activities, 22 p. plus appendices, 1978. (prepared by P. Campbell, W. Brimley)

SUMMARY

The Inland Waters Directorate is interested in a relatively broad range of sediment related activities ranging from the collection of sediment transport data for rivers and lakes for both quantity and quality evaluation to the studies of sediments for dating of events in the eutrophication cycle.

In total the Directorate devotes approximately 65 man years of time and $2 million annually to these activities. In most cases this represents less than 10% of the resources available to the three major participants in the program.

The Water Survey of Canada conducts the major individual sediment program in conjunction with its hydrometric (water quantity) survey. This program is cost shared in accordance with the agreements with the Provinces and the arrangements with the Department of Indian and Northern Affairs. The remaining programs fall into the category of studies and research designed to improve the understanding of the sediment-water complex and to develop ways and means to overcome sediment problems in water projects, to predict the effects of man's activities on the environment, and to improve the methodologies for applying the results of research to water management.

INLAND WATERS DIRECTORATE

Sedimentation Survey Parkhill Reservoir (1970), 71 p., 1972. (prepared by L. Drennan)

ABSTRACT

The 1970 Sediment Survey of the Parkhill Reservoir is described in this report.

This was the first of a series of at least three surveys which are to be conducted at this reservoir. Thirty-seven cross-sections were established within the reservoir and their profiles were surveyed. Sampling of bed material and suspended sediment was also carried out during the survey. The survey results are illustrated by tables and graphs in the Appendices of the report.

Recommendations include a plan for subsequent surveys of the reservoir and an extension of the present study to include the entire watershed area. The former should provide sufficient data to enable evaluation of the rate of sedimentation and its effects on reservoir storage. The latter will produce a relationship between watershed properties and sediment production from the watershed.

INLAND WATERS DIRECTORATE

South Nation River Sedimentation and 1971 Landslide Studies, 13 p. plus appendices, 1977. (prepared by G. Cavanagh)

ABSTRACT

This report contains a description of the physiography, survey procedure and survey results on a 26 (twenty-six) mile length of the South Nation River between Casselman and the Ottawa River.

In May of 1971, a large slide occurred along the South Nation River approximately four miles north of Casselman. The material which slumped into the river dammed the main channel for a period of several months. The opening of a new channel resulted in the degradation of the recent deposits at the slide and subsequent deposition of this material in areas of lower velocities downstream of the slide site.

The purposes of this survey were to obtain sufficient data upon which to base an estimation of the volume of earth moved during the slide and to do the ground work required to prepare for subsequent surveys in an attempt to evaluate the sedimentation rate in the channel.

The survey consisted of planning, establishing and profiling 29 equally-spaced ranges. Bed and bank material samples were collected across each range and suspended sediment samples were collected at three different locations along the stretch of the river. The survey results are illustrated by tables and graphs in the Appendices of the report.

Recommendations include a plan for possible subsequent resurveys of the river based upon experience gained during the 1973/1975 survey. These data should provide sufficient information for an evaluation of the conditions concerning present rates of erosion and deposition.

INLAND WATERS DIRECTORATE

Supplement to Fanshawe Reservoir 1972 Sedimentation Study, 21 p.
(prepared by G. Cavanagh)

ABSTRACT

This is a supplement to the Fanshawe Reservoir 1972 Sedimentation Study. The Fanshawe reservoir is located in Ontario.

It was impossible at this time, due to reservoir conditions, to actually resurvey the reservoir. Therefore photographs and bed material samples were taken at various locations in an attempt to show how conditions had changed since 1972.

It is from these photographs and sample analyses that the conclusions have been formulated.

From soundings and visual inspections, it would seem that most of the depressional areas have become loci for sediment deposition with sediment depths ranging from 2-5 feet. In the flat areas, there appears to be at the most 1/2 to 1 foot of sediment. Bottom features are quite evident with many beams and bars having been formed as a result of bed load movements or hydraulic influences owing to reservoir morphology.

In general, it would appear that in 23 years of operation only a minimal amount of sediment has been deposited.

JORDAN, P.

Impacts of Mass Movement Events on Rivers in the Southern Coast Mountains, British Columbia: Summary Report, 62 p., 1987.

ABSTRACT

A study has been conducted in the southern Coast Mountains of British Columbia to investigate the impact of terrain hazards on the geomorphology and flood hydrology of rivers. Such hazards include debris flows, slope failures in unconsolidated material and bedrock, and the drainage of moraine- or ice-dammed lakes. Impacts are most frequently due to the sudden introduction of large quantities of coarse sediment to a river channel. In rare cases, complete blockage of a river channel by a landslide or debris flow can be followed by an outburst flood.

A system for the classification and mapping of terrain hazards and their impacts on river channels has been proposed, and applied to a representative study area, the Squamish and Lillooet watersheds. In this study area, the most frequent and most severe impacts result from landslides and debris flows in Quaternary volcanic complexes. Most other river channel impacts result from debris flows originating in small, steep tributary basins. The potential for large slope failures which could completely block main-stem rivers exists in several locations. Although no longer a significant hazard in the study area, outburst floods from moraine- or ice-dammed lakes present potential hazards elsewhere in the Coast Mountains.

RÉSUMÉ

On a réalisé une étude dans la chaîne côtière du Sud en Colombie-Britannique afin d'examiner les effets des accidents de terrain sur la géomorphologie et l'hydrologie des cours d'eau en période de crue. On entent par de tels accidents des coulées de débris, l'éboulement de matériaux non consolidés et de la roche-mère, ainsi que le drainage de lacs de barrage par moraine ou de lacs de barrage glaciaire. L'introduction soudaine de grandes quantités de sédiments grossiers dans le chenal d'un cours d'eau entraîne le plus souvent ces effets. Dans de rares cas, un glissement de terrain ou l'écoulement de débris peut bloquer complètement le cours d'eau, et une inondation subite peut s'ensuivre.

On a proposé un système visant à classifier et à cartographier les accidents de terrain et leur incidences sur les chenaux des cours d'eau et on l'a appliqué à une région d'étude représentative, celle des bassins versants des rivières Squamish et Lillooet. Dans cette région, les incidences les plus fréquentes et les plus graves sont dues à des glissements de terrain et à des coulées de débris dans les complexes volcaniques du Quaternaire. Des coulées de débris en provenance de petits bassins tributaires profonds sont la cause de la plupart des autres incidences sur les chenaux. De graves éboulements qui bloqueraient entièrement les branches principales de cours d'eau pourraient se produire à plusieurs endroits. Bien que les inondations subites dues à des lacs de barrage par moraine ou à des lacs de barrage glaciaire ne présentent plus de dangers potentiels ailleurs dans la chaîne cotière.

KEENE, R.G. and TYWONIUK, N.
"Sediment Survey on the Fraser River at Port Mann", Water Ways, No. 13, p. 16-22, June 1967.

SUMMARY

The Fraser River in British Columbia is one of Canada's largest rivers. A sediment survey program was started on the lower Fraser River in 1964 at the request of the Department of Public Works Canada to obtain reliable information on the sediment load carried by the river, for navigation purposes. This article describes the survey for the Fraser River at Port Mann, one of nine stations in the Lower Mainland area. The sediment survey at Port Mann includes the sampling of suspended sediment, bed load and bed material, and of measurement of variables used in streamflow calculations.

KELLERHALS ENGINEERING SERVICES LTD.
Morphological Effects of the Churchill River Diversion, Volume 2, Feasibility Study and Monitoring Recommendations, 102 p., 1988.

ABSTRACT

The present report is Volume 2 of a two volume series and discusses the second phase of a study on the changes in river morphology which have resulted from the Churchill River Diversion. In Volume 1 morphological effects are discussed on the basis of data and reports available in Spring 1987, combined with the results of a brief field inspection. Future morphological monitoring requirements are discussed in relatively general terms and recommendations are made for several office studies to develop a detailed field and office monitoring program. These studies have now been carried out and their results are reported here.

Since completion of Volume 1, several directly relevant studies have been made available. They are reviewed here in Section 2. Manitoba Hydro's study of the open-water hydraulics of the diversion route between the Notigi Control Structure and Split Lake confirms that erosion along the channelized part of the diversion route is not causing large-scale morphological changes. Effects on water levels are mostly quite localized, however the post-diversion water levels of Birchtree and Opegano Lakes have dropped by 0.8 and 1.2 m, respectively, due to erosion at the controlling channel sections. Erosion on a scale to affect flows and water levels is clearly limited to some of the major rapids. The Symbion Consultants study of the extent of flooding in the Nelson House Trapping Block, undertaken for the Northern Flood Committee, tabulating the results are different and the studies are therefore difficult to compare.

Investigating the feasibility of using maps and air photos to quantify morphologic changes is one of the main objectives of this study. In Volume 1 shoreline stability, flooding, floating debris, standing dead trees, and areas of shallow water depth are identified as the morphologic changes of most direct relevance to the Northern Flood Committee Bands. Using air photos of Footprint and Threepoint Lakes, we now show that these features can be quantified in a useful manner. The results show drastic changes, particularly in shoreline stability and in the extent of debris-clogged water. Longterm changes in these parameters are also of scientific interest. The results of the present study could be improved considerably by conducting field work to ground truth the air photo interpretations and by obtaining air photos and video documentation flown specifically for this type of application.

Besides trying to determine the areal extent of the effects mentioned above, erosion volumes are also estimated for a few severely eroding sites. The objective was to determine the feasibility of quantifying erosion rates on the basis of air photo interpretation and to compare the calculated erosion volumes with the preliminary sediment budget for the Churchill River Diversion (based on 1977-1978 data) discussed in the companion study on sediment transport undertaken by Northwest Hydraulic Consultants.

The results of this investigation, presented in Section 3, indicate that sufficient photography is available to allow the determination of erosion rates at sites undergoing relatively rapid rates of retreat. Analyses of sites fully exposed to wave erosion on southern Footprint and Wuskwatim Lake indicate no

detectable shoreline erosion occurred over the period between the mid-1950's and the early 1970's. Following completion of the Churchill Diversion, rates of shoreline erosion increased dramatically, with average recession at the study sites ranging from 2 to 3 m/yr. This corresponds to an annual sediment production of approximately 6 m^3/yr per linear metre of shoreline eroded.

Rates of shoreline erosion were also estimated along two river reaches containing sections of rapids. Data from Gods, Caribou and Early Morning Rapids (located between Threepoint and Wuskwatim Lakes) indicate that, while no detectable erosion occurred in the 1954 to 1970 period, shoreline recession appears to have produced an average of 1.6 to 6.5 x 10^4 tonnes/yr of sediment in the period 1977 to 1981 and 1.2 to 4.8 x 10^4 tonnes/yr in the period 1981 to 1985. This average 1977 to 1981 erosion volume represents 6 to 22 per cent of the estimated annual sediment entrainment in the area between the inlet to Threepoint Lake and the exit of Wuskwatim Lake. The comparatively small amount of material being eroded from this section of rapid, combined with the documented high rates of shoreline recession on Wuskwatim and Footprint Lakes, suggests that much of the sediment entrained in the above reach is coming from lake shore erosion, possibly with a significant contribution from the upper Burntwood River.

Similar erosion studies were conducted at First Rapids (located 14 km upstream of the confluence of the Burntwood River and the Odei River). These analyses indicate that substantial increases in rates of erosion occurred following the Churchill Diversion. Average sediment production at this site during the period 1977 to 1981 is estimated to be 2.2 to 9.7 x 10^4 tonnes/yr. This represents 14 to 65 per cent of the estimated annual sediment entrainment in the reach between First Rapids and Manasan Falls. Shoreline erosion is also occurring in the vicinity of Second and Third Rapids and it therefore appears that localized bank erosion is an important sediment source in the lower section of Burntwood River.

Morphological changes along the lower Churchill River are addressed briefly in Section 4 and found to be developing slowly. Although the river will eventually look very different from its present state, both the stable, bedrock-controlled nature of the river channel and the harsh climate of the area assure that changes are taking place at a very slow rate.

The Churchill River diversion has had such widespread effects that there are many morphological parameters undergoing change and they could all be monitored. In Section 5 we discuss how the significant morphological changes arising from the diversion could be monitored and then try to attach priorities from two perspectives. The proposed studies are first rated by what we estimate to be the requirements of the Northern Flood Committee, which we see as quantifying those changes that affect their band members (e.g., changes in shoreline stability, floating
debris, sedimentation of fish spawning areas, etc.). The second priority rating is based on the potential contribution of any study to the general scientific understanding of the processes involved. In addition, all studies are rated by the degree to which residents of the study area might be involved in the monitoring work.

As the morphological monitoring program for the diversion route has to be planned to accommodate Manitoba Hydro's proposed three further hydro-electric developments, the recommended field sites have been preferentially located above and below the potential reservoir areas. However, the three projects, for which forebay elevations and operating regimes are only ill-defined at present, will clearly have major morphological effects. To some extent the data relevant to predicting the environmental impacts of the additional dam sites. Some pre-project "base-line" monitoring may be desirable however and, once any of these proposals reach the construction stage, there will be a need for further, project-specific, morphological monitoring.

Since the morphological studies outlined in Section 5 tend to be very expensive - clearly too expensive to be carried out under the ongoing federal ecological monitoring program, we are recommending a scaled-down, minimal morphological monitoring program, concentrating on areas and issues most relevant to the residents of Nelson House and Split Lake. This program would provide reasonably detailed quantitative morphologic data for Threepoint and Footprint Lakes and for the Burntwood River between First Rapids and Split Lake. The proposed studies would cost on the order of $50,000. Some results would be of immediate use but, to gain maximum benefits from such a program, it would need to be repeated several times at intervals of 5 to 10 years.

KELLERHALS ENGINEERING SERVICES LTD.
Review of Sediment Survey Program, Lower Fraser River, British Columbia, 50 p., 1984.

INTRODUCTION

The Fraser River originates in the Rocky Mountains some 30 km southwest of Jasper and drains 233,000 km^2 of south-central and south-western British Columbia to the Straight of Georgia. The term "Lower Fraser River" generally refers either to the lowermost 190 km navigable reach of the river from Yale (at the mouth of the Fraser Canyon) to Sand Heads (a navigation light at the outer edge of the delta) or to the somewhat shorter (165 km) alluvial reach from Hope to Sand Heads. This latter reach corresponds to the present study area.

Continuous flow and sediment transport data are available for four sites along the lower Fraser, although occasional data have been obtained elsewhere (Zyrmiak, 1982; Church et al., 1984). The four sites, with the corresponding distances from Sand Heads along the thalweg, are Hope - km 165, Agassiz - km 130, Mission - km 84, and Port Mann - km 43. A detailed discussion of data available in 1984 is presented subsequently in Section 2.

The runoff regime of the Fraser River at Hope is snowmelt dominated. Over the seventy-one years of continuous flow records at Hope, annual peaks have ranged from 5130 m^3/s to 15,600 m^3/s, with a mean of 9600 m^3/s, and have occurred between May 1 and July 16.

The annual low flows range from 340 m^3/s to around 900 m^3/s and occur between late November and early April. Mean annual runoff is 86.2 X 10^6 dm^3 over the period of record. Runoff for the period 1952 to 1982 is significantly greater than for the previous 30 years, and this in spite of a major diversion of flow out of the Fraser drainage (see below).

The lowermost 20,000 km^2 of the Fraser drainage area is subject to very intense autumn and early winter rainstorms due to large-scale frontal disturbances moving eastward from the Pacific and rising over the Coast and Cascade Mountains. The storm of December 26, 1980 is a good example of this situation. At Hope, flows reached 4210 m^3/s on December 27, 1980, well below the annual peak of 6170 m^3/s of June 22nd. The drainage area increase from Hope to Mission amounts to only 5 percent.

The extent of the tidal reach of the Fraser varies with flow. At low flows it reaches to Sumas Mountain at km 95, but with Hope flows exceeding 5000 m^3/s tidal effects at Mission become very small. Flows reverse at Port Mann until the flow at Hope exceeds 4000 m^3/s (Ages and Woollard, 1978). Salt water from the Straight of Georgia can intrude some distance into the Fraser estuary. depending on flow and tide range. With low Hope flows and large tides the salt wedge may reach New Westminster (km 35), but under freshet conditions it rarely extends beyond the Steveston Bend, km 10 (Beak, 1981).

Morphologically the lower Fraser can be divided into three distinct reaches. From Hope to Sumas Mountain the river is a wandering, split and unstable gravel-bed channel, frequently confined by bedrock spurs and by rip-rap-protected embankments. Confinement decreases below Hope as the valley widens. At km 95 there is an abrupt transition to a single, sinuous channel with a sand bed, frequently confined by pleistocene uplands. The delta reach starts at New Westminster, where the river splits into three distributaries.

The Fraser River has large commercial and recreational fish resources, primarily based on the five species of Pacific Salmon. Almost the entire main stem and most significant tributaries are utilized by salmon and this is the primary reason why the river remains essentially unregulated.

Only two tributaries of the Fraser River above Hope are significantly affected by regulation. The Nechako River above Kenney Dam would contribute some 8.5 percent to the flows at Hope (See Table 1.1). Of this, some 108 m^3/s or 4.6 percent of the Hope flows are diverted out of the Fraser drainage and 91.3 m^3/s or 3.9 percent are returned to the Fraser in a regulated manner, but a further 50 m^3/s may be diverted within the next 5 to 10 years. regulation of the Bridge River affects 4.3 percent of the Hope flows. Several tributaries to the tidal reach below Mission, the Stave, Alouette and Coquitlam Rivers are also regulated (Beak, 1981).

Over 1 million people live within a few kilometres of the lower Fraser River and the lowermost 37 km are navigable for oceangoing vessels. The remainder of the study reach is also navigable but is primarily used for towing logs, barging forest products, gravel and quarried rock, fishing and pleasure. Maintenance of the navigation channel is an ongoing problem. Below Port Mann, annual dredging is required. Several million cubic metres of sand are moved each year. The gravel-bed channel above Sumas Mountain also requires some maintenance in order to remain navigable.

The lower Fraser has a floodplain of some 82,000 ha, most of which is developed and protected from flooding by an extensive system of dikes, drainage canals and pump stations. The large freshet of 1948 flooded some 25,000 ha of developed land (Fraser River Joint Advisory Board, 1976).

KELLERHALS, R., ABRAHAMS, A.D., and VON GAZA, H.
Possibilities for using Suspended Sediment Rating Curves in the Canadian Sediment Survey Program, 136 p., 1974.

ABSTRACT

Sediment rating equations for predicting mean daily suspended sediment concentration and load from the corresponding water discharge have been developed for five river sites in Alberta and in western Saskatchewan for which four to nine years of daily suspended sediment data are available. The technique used to fit rating equations to the data is stepwise multiple linear regression which is applied to log-transformed data. At most sites only mean daily discharge (Q) makes a significant contribution towards explaining mean daily concentration (C), and the contributions of discharge-related variables, such as "rate of change of discharge" or "time from spring rise" are generally negligible. The residuals of the regression are serially correlated to such a degree that the significance tests normally applied to regressions are meaningless. Plots of the residuals show that the rating equations give poor predictions of C, both during the spring rise in Q and whenever major rainstorms occur on the plains portion of the river basins. A preliminary attempt to improve prediction during major rainstorms by including regionally averaged precipitation into the rating equations was unsuccessful. By themselves, rating equations or curves do not give a satisfactory representation of suspended sediment data, because they fail to represent properly the expected distribution of C. Rating equations based on log-transformed daily data also tend to underestimate long-term sediment yields. Monthly and yearly rating curves can, however, be used for this purpose. A considerable number of other studies concerning rating curves are reviewed and the findings of the present study are shown to be in general agreement.

The objectives of the Sediment Survey program are stated in a form which differs somewhat from the official published version, but which is essentially equivalent. The degree to which the present survey program meets these objectives is then discussed and some suggestions are made on how a survey program based on the extensive use of rating equations could permit a closer approach to the objectives.

KELLERHALS, R. and MILES, M.

Qu'Appelle River Channelization Project: Recommendations for a Morphological Monitoring Program, 1990.

ABSTRACT

This report discusses the probable future morphological evolution of a major channelization project along the Qu'Appelle River in south-eastern Saskatchewan. A monitoring program is proposed to document any morphological changes and to provide timely warning in case of unforeseen detrimental developments.

Along most of its course, the Qu'Appelle River consists of a small, tortuously meandering channel in a relatively large and deep valley formed by glacial meltwater. The river flows through several shallow lakes, which are formed where alluvial fans of tributaries block the main valley. The flow regime of the Qu'Appelle River is characterized by extreme variability both within the year and from year to year. This in turn is the main cause of long-standing water supply, water quality and flooding problems.

A major water management effort to address these problems is mostly completed and includes diversion of South Saskatchewan water into the Qu'Appelle River, flow control structures at several lake outlets and channelization of the Qu'Appelle River from Craven to Pasqua Lake; this being the subject of the present report. The channelized river reach is to be shortened from 110 km to 75 km by cutting off particularly tortuous meander bends, and the channel capacity is to be increased from around 5 m^3/s to 14 m^3/s, mostly by enlarging the natural channel. Only some two thirds of this latter part of the Qu'Appelle project is presently completed.

The channelization was designed as a rigid channel without any explicit allowances for sediment transport, erosion, deposition or vegetation encroachment. There has been some concern that the increased energy gradient and increased velocities could lead to degradation and erosion problems. A computer study using the sediment routing model "MOBED" predicted extensive degradation near Craven and led to some initial monitoring work. These results were also indirectly responsible for the commissioning of the present study. To date the channelized reaches of the Qu'Appelle River show no significant evidence of degradation but, due to the very low flows of the last few years, this does not alleviate all concerns.

Comparison of the pre- and post-construction channel of the Qu'Appelle River with various published channel design criteria and with documented case histories for comparable rivers on the Canadian prairies, indicates the following:

(i) The post-project channel has a bankfull capacity that is probably somewhat larger (17-32m^3/s) than the design flow of 14.2 m^3/s;

(ii) The project does not appear to affect channel width and the final channel is, if anything, somewhat wider than necessary for the expected flows; and

(iii) Both the pre- and post-project gradients are very low, even for prairie rivers. Significant bed load transport or significant channel bed

degradation are therefore most unlikely.

Based on evidence from case histories, the morphological evolution of the channelized reach is predicted qualitatively at three time scales; short term (years), medium term (decades) and long term. Morphological parameters are not expected to change dramatically at any of these time scales.

In view of the predicted slow rates of morphological change, only a very limited monitoring program appears necessary, consisting of the following:

(i) river channel cross section surveys;

(ii) collection of some bed material samples;

(iii) photographic documentation of morphological changes and vegetation encroachment;

(iv) documentation of changes in channel plan from air photos, if and when suitable photos become available from other projects;

(v) monitoring water level trends at the two Water Survey of Canada gauges in the channelized reach; and

(vi) field inspection during or immediately after any large floods.

An initial monitoring interval of 5 years is suggested, but this needs to be varied according to the occurrence of floods. There is little point in repeating any surveys unless there have been some significant flows since the previous one. Major floods might justify immediate re-surveys.

RÉSUMÉ

Aussi disponible en français.

KELLERHALS, R., MILFS, M., and DAY, T.J.
"Morphological Effects of the Churchill River Diversion", Proceedings of Technical Session D: Environmental Hydraulics, International Association for Hydraulic Research, XXIII Congress, August 21-25 1989, p. 375-382, 1989.

SUMMARY

The Churchill River, Manitoba, diversion offers an opportunity to observe the environmental and societal impacts of major water engineering schemes in northern latitudes.

Diversion of the Churchill River into the Rat-Burntwood system has resulted in extensive flooding, the widespread inundation of vegetation and destabilization of shoreline areas. If the diversion continues to be operated in its present manner, it may take 50-100 years for a stabilized shoreline configuration to develop and for riparian vegetation communities to become fully re established. The planned development of additional dam sites, however, will raise water levels yet again in many areas and this will result in a new sequence of flooding and shoreline stability.

For local residents the diversion has caused dramatic changes to the area in which they live, hunt, trap and travel.

From a scientific perspective, a knowledge of the timescales for the decomposition of inundated vegetation, the stabilization of shoreline areas and the re-development of riparian vegetation communities are of considerable interest. Beyond erosion studies at certain sites of interest to Manitoba Hydro, no systematic monitoring program now exists. With the potential for knowledge transfer to future northern waters developments, monitoring efforts along the Diversion should be focused upon: the mapping of shoreline features and the calculation of shoreline retreat and changes in shoreline characteristics over time, and calculation of erosion volumes; and field measurements to ground truth mapping results. It is most important to relate erosion rates to shoreline characteristics.

KRISHNAPPAN, B.G.
Distribution of Suspended Sediment in Ice-Covered Flows, 32 p., 1981.

ABSTRACT

The vertical distribution of the suspended sediment in two-dimensional, uniform and fully developed turbulent flows under ice cover is formulated using the results of the κ-ε turbulence model of Launder and Spalding. Three sets of distribution curves each corresponding to a particular value of the ratio between the ice cover roughness and bed roughness are presented in a form similar to the distribution curves of H. Rouse for free-surface flows. For the same value of the ratio between the shear velocity and the fall velocity of sediment particles, the relative concentration is less in ice-covered flows than in free-surface flows. Under similar conditions, the relative concentration of suspended sediment decreases as the ratio of ice cover roughness to bed roughness increases. The agreement between the present formulation and the measurements found in the literature is favourable.

RÉSUMÉ

La distribution verticale des sédiments en suspension dans un écoulement turbulent bidimensionnel en régime permanent sous une couverture de glace est décrite à l'aide des résultats du modèle de turbulence κ-ε de Launder et Spalding. Le présent article traite de courbes de distribution réparties en trois ensembles dont chacun correspond à une valeur particulière du rapport des rugosités de la couverture de glace et du lit; elles sont analogues aux courbes de distribution de H. Rouse pour les écoulement à surface libre. À valeur égale du rapport de l vitesse de cisaillement à la vitesse limite de chute, la concentration relative des sédiments dans un écoulement couvert de glace est inférieure à celle dans un écoulement à surface libre et elle diminue avec l'augmentation du rapport des rugosités de la couverture de glace et du lit. Cette formulation donne des résultats qui concordent avec les valeurs expérimentales rapportées dans la documentation.

KRISHNAPPAN, B.G.
MOBED vs HEC-6 A Comparative Study, 24 p., 1984.

ABSTRACT

Models MOBED and HEC-6 were compared in this study. The comparison consisted of two steps. In step one, the major differences between the models were identified by examining the theoretical base of both models. In step two, the predictive capabilities of the models were compared by applying the models to an identical data set. The data set comes from the South Saskatchewan River reach below Gardiner Dam and relates to the degradation process that has taken place since the creation of Lake Diefenbaker. Comparison of model predictions with measurements reveals that MOBED has superior predictive capability than HEC-6 and use of HEC-6 as a predictive tool requires an extensive model calibration by the adjustment of Manning's 'n' and moveable bed width.

RÉSUMÉ

Cette étude compare les modèles MOBED et HEC-6. La comparison comporte deux étapes. La première consiste à identifier les différences majeures entre les modèles en examinant les fondements théoriques de chacun. Dans une deuxième étape on a comparé les capacités de prévision des modèles en les appliquant à un même ensemble de données. Ces données proviennent du tronçon de la rivière Saskatchewan-Sud situé à l'aval du barrage Gardiner et sont reliées au phénomène de dégradation observé depuis la création du lac Diefenbaker. La comparison des prévisions des modèles aux mesures révèle que le MOBED présente des capacités de prévison supérieures au HEC-6 et que l'utilisation du HEC-6 comme instrument de prévision nécessite un étalonnage complet du modèle par ajustement du "n" de Manning et de la largeur du fond mobile.

KROL, M., LAMONTAGNE, G., and CASHMAN, M.A.
Publication Procedures for Sediment Data, First Edition, 49 p., 1979.

SUMMARY

This is the first edition of a manual on publication procedures for sediment data. This manual deals with annual sediment data publication, historical sediment data summary publication, and sediment data reference index publication. There are three phases in the publication process after data have been verified: data pages for individual publications are produced from data files as line images on magnetic tape, using computer programs; introductory test material is prepared through a special typewriter terminal; and manuscript material is assembled and sent for printing.

LAM, C.S.

A New Computation Procedure for Bottom Withdrawal Tube Particle Size Analysis, 8 p., 1981.

SUMMARY

A computation procedure is presented to calculate cumulative percentage of selected particle sizes. It is based on a method developed by Lam in conjunction with least square spline approximation. The program was tested on 125 samples from 40 water resource stations in 11 provinces and territories in Canada. Of the 125 samples, only two failed to produce satisfactory results. The program was developed for the Sediment Survey Section by the Scientific Computing and Applied Statistics Directorate.

LAPOINTE, F.

Étude de la representativité de l'échantillonneur automatique PVS basée sur les données existantes, 140 p., 1984.

INTRODUCTION

L'utilisation de l'échantillonnage automatique au Canada débute en 1970 avec l'acquisition des modèles américains US-PS67 et SIRCO. En 1972 nous commençons à se servir d'un échantillonneur canadien, le PWS. Depuis sa mise en opération, peu d'études ont été effectuées. Au total il y a eu un rapport sur des essais en laboratoire et deux rapports traitant de son comportement sur le terrain. Le rapport du laboratoire concluait que l'échantillonneur automatique donnait des résultats satisfaisants tandis que les deux autres rapports affirmaient le contraire. Sur le terrain lorsque les conditions étaient mauvaises, les concentrations obtenues par le PWS montraient des variations élevées pour des échantillons pris successivement.

LAPOINTE, F.

Étude de la variabilités des méthodes d'échantillonnage des sédiments en suspension pour des concentrations inférieures à 50 mg/L, 45 p., 1985.

INTRODUCTION

Cette étude a été faite à partir des recommandations du rapport "Etude de la Représentativité de l'Echantillonneur Automatique PWS Basée sur les Données Existantes". Une carence de renseignements concernant la variabilité des méthodes d'échantillonnage avait été constatée. Dans le but d'acquérir ces renseignements, un programme de relevés a été entrepris en Alberta, au printemps 1983. Initialement, l'étude de deux rivières à granulométrie différente avait été envisagée. Malheureusement, les faibles concentrations rencontrées nous ont contraint à n'étudier qu'une seule station, HIGHWOOD RIVER NEAR THE MOUTH (05BL024) et de ne traiter que des concentrations inférieures à 50 mg/L.

LAPOINTE, F.

Étude du comportement hydraulique de l'échantillonneur automatique PWS, 41 p., 1986.

SUMMARY

The evaluation of the precision and the improvement of the automatic suspended sediment sampler, PWS, are two important projects of the Sediment Survey Section.

The principal factors influencing the precision of the PWS are: the shape and the size of opening (diameter of the intake), the intake velocity and the capacity of the hydraulic system. Ironically these factors concerning the PWS have never been thoroughly studied. Taking this into consideration, several tests were conducted at the NWRI Laboratory (Burlington) in August, 1984.

This report provides an insight into the different tests and their results. Comments and possible applications of the results for future installations are also presented. From the interpretation of the test results, the following recommendations are presented for improving the hydraulic aspects of the PWS:

1) Eliminate the Water Motor from the Control Unit of the PWS;

2) Improve the bottling system by reducing the flow resistance in the following manner:

- eliminate the roughness caused by the protrusion of secondary pipes in the collector system,

- eliminate the constriction of the soft tubing used as elbows for the manifold;

3) Reduce the diameter of the sampler inflow by adapting a nozzle. Prototype nozzles are suggested in Section 2.7, however, further study should be carried out to improve the nozzle design.

4) Outflow from the manifold should be released to an open system (i.e. released to atmospheric pressure).

This is one step in a series of investigations about the PWS. Additional investigations must be carried out to determine the correlation between the PWS results and the single vertical sampling results. The design of the PWS must be improved in order to increase sampling efficiency and to facilitate instrument operation.

LAPOINTE, F.
Évaluation de rendement de pompes compatibles a l'échantillonneur automatique PWS, 40 p., 1987.

SUMMARY

This report presents the results of hydraulic test carried out to establish the (head of water)-(discharge) curves for three pump models: Warren Rupp SPA1/2E, Jaccuzi BS4 and Hydromatic SP 50 MH. These pumps were selected by taking into account their compatibility with the automatic suspended sediment sampler, PWS. To complete the evaluation of these pumps, the interpretation of the results were based on constraints on the pumps resulting from the installation characteristics of the PWS[1]. The constraints on the pumps are the flow resistance of the hydraulic system of the PWS and the static head between the water level and the manifold system of the sampler.

The results show that the Jaccuzi BS4 is the superior pump because it supplies the most discharge to the BWS. However, for a station that does not have an alternating current (AC) power supply, the Warren-Rupp (a DC pump) is the best choice. The Hydromatic pump SP 50 HM, is not recommended for use with the PWS because the discharge above. The results of laboratory test indicate the SP 50's performance is lower than the company's specifications.

The results also indicate that the PWS must use a sampling nozzle equal to or lower than 13 mm diameter. This will permit the pump to operate at a greater static head between the water level in the stream and the manifold system of the sampler, and ensure an adequate sampling velocity.

SOMMAIRE

Aussi disponible en français.

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[1] Etude du comportement hydraulique de l'échantillonneur automatique, PWS, Lapointe F, Environment Canada.

LAPOINTE, F.

Méthodes d'échantillonnage des sédiment en suspension - variabilité et correlation, 75 p., 1987.

SUMMARY

Water Survey of Canada makes use of automatic sampling systems for collecting suspended sediment data. The use of these systems permits better data coverage at stations and enables expanding the network at costs lower than for traditional methods and at sites with difficult access. In order to interpret and analyse the data from these new systems, it is necessary to have an in-depth understanding of the behaviour of the factors causing the variability within each sampling method and amongst several sampling methods.

Intensive sampling of suspended sediment concentrations was carried out during the period from 23 March to 2 April, 1985 at the hydrometric station "BIG OTTER CREEK NEAR CALTON", 02GC026, in Ontario. The percentage of sand in suspension was particularly high. Sampling had been initiated in order to establish the variability in sampling methods and the correlations between them. The sampling methods studied were:

- five vertical sampling by the depth integrating method;
- single (control) vertical sampling by the depth integrating method;
- manual sampling at a point;
- automatic sampling at a point.

Simple and stratified statistical sampling models, graphical interpretation and field observations were used in the analysis.

The study permits some quantitative demonstration of the differences amongst sampling methods and the types of samplers used for Canadian sampling sites. It has also provided an evaluation of the efficiency of the automatic PWS samplers. The precision of the sampling methods are notably similar and in the order of five percent for suspended sediments of the silt and clay sizes. Differences amongst the sampling types and methods have been observed to be more noticeable for sand size suspended sediments. Precisions from ten to twenty percent were observed. The precision of the manual point sampling is less sensitive to the presence of sand in suspension. Although single depth integrations are less precise then point integrations, the integrated sampling at five verticals estimates the mean concentration to a fairly good degree of precision. The confidence interval to 95% of the mean concentration was in the order of three percent for samples containing nearly fifty percent sand. The automatic PWS sampler was the instrument where the variability was the most sensitive to sand in suspension. It was also with this sampler that the largest quantity of outlier data were observed.

Results demonstrate that correlation between sampling methods is difficult to establish as both individual method precision and changing relationships between methods over the duration of a "sediment event"
influence the correlation. After removing the effects of sampling precision, the linear relationship defining the relationship between the manual methods has a standard error of estimate of six percent. The standard error was twelve percent for the correlations between the PWS automatic sampler and the manual methods.

This report allowed the establishment of the efficiency of the PWS automatic sampler. Although the use of this method increases the uncertainty of the data, the data are for the greatest part representative of the true behaviour of the sediment in suspension. The principal weaknesses of this method are that both the data analysis and the correlation are actually difficult to establish. These weaknesses are evident for all automatic samplers. Other studies on automatic samplers are necessary before integrating this method into the Canadian network. The development of a data analysis program and evaluating the cost-benefit ratio of such a program are examples of studies to undertake.

SOMMAIRE

Aussi disponible en français.

LAPOINTE, F., MacLEOD, D.A., and CHOPRA, A.
Test of Automated Sediment Sampler, 21 p., 1986.

SUMMARY

A PWS automatic sediment sampler, daily vertical sampler, and point-integrating sampler were tested and the results compared. Statistical analysis showed that if the automated sampler was used as a substitute for the vertical sampler there would be an increase in the standard error of each measurement due to two factors (the PWS has a greater measurement error, and, some additional error will be introduced during the process of converting the values from one sampler to the other). This increase should not be that large, however. When measurements are averaged over a period of time, the second factor will become relatively more important as it is not reduced as much as the first factor in the averaging process. The sand portion of the sediment shows a greater peak with the PWS than with the other two samplers, indicating that the intake of the PWS may have been closer to the bed of the river. This could also have contributed to the greater measurement error found for the PWS sampler.

LAPOINTE, F., YUZYK, T.R., DAY, T.J., and McCULLOCH, G.R.
An Interagency Comparison of the Field and Laboratory Procedures for Determining Suspended Sediment, 26 p., 1989.

ABSTRACT

A controlled field study was undertaken to determine whether the suspended-sediment data collected by four agencies working along the Churchill River Diversion in Northern Manitoba are comparable. The results show that a negative bias (≈12%) in concentration is introduced when collecting a dip as opposed to a depth-integrated sample in a wash load dominated river. Further errors (10-30%) are introduced as a result of sample splitting, which is commonly done by the federal and provincial water quality agencies. The implications of these findings to future NFA work are discussed. Recommendations as to future sampling strategies and methods to be used in northern Manitoba are also put forth.

RÉSUMÉ

Une étude témoin a été effectuée sur le terrain afin de déterminer si les données sur les sédiments en suspension recueillies par quatre organismes le long de la dérivation du fleuve Churchill, dans le nord du Manitoba, sont comparables. Les résultats montrent que, dans un cours d'eau caractérisé par la prédominance de la charge de ruissellement, la concentration présente un écart négatif (≈12%) lorsque l'on prélève un échantillon en surface par opposition à un échantillon intégré sur la profondeur. D'autres erreurs (10-30%) sont également introduites lors de la subdivision des échantillons, une pratique courante chez les organismes fédéraux et provinciaux oeuvrant dans le domaine de la qualité de l'eau. Les répercussions que ces résultats pourraient avoir sur les futures activités dans le cadre de l'accord relatif aux crues dans le Nord sont examinées. On recommande aussi l'adoption de méthodes et de stratégies d'échantillonnage pour le nord du Manitoba.

LAU, Y.L. and KRISHNAPPAN, B.G.
Sediment Transport under Ice Cover, 44 p., 1984.

ABSTRACT

A method for calculating sediment transport for ice-covered flows has been developed. Laboratory data on bed form, frictional characteristics and sediment transport were obtained for equivalent free-surface and covered flows. Comparison of the data leads to the conclusion that the lower layer in a covered flow can be treated as a free surface flow for the purpose of calculating bed load transport. Using the flow characteristics calculated from the κ-ε turbulence model and a conventional bed load equation, the sediment transport for covered flows can be obtained. The method was verified using measured data.

RÉSUMÉ

On a mis au point une méthode de calcul du transport des sédiments dans le cas d'écoulements d'eau sous surface de glace. On a obtenu des données d'expériences en laboratoire sur la configuration du lit, sur les caractéristiques de frottement et sur le transport des sédiments, pour des écoulements équivalents sous surface libre et sous surface couverte. Après comparaison des données, on a conclu que l'on pouvait traiter un écoulement sous surface couverte comme un écoulement sous surface libre, pour calculer le transport de la charge de fond. En utilisant les caractéristiques d'écoulement calculées à partir du modèle de turbulence κ-ε et d'une équation conventionnelle de la charge de fond, on a obtenu le résultat relatif au transport dans le cas d'un écoulement sous surface couverte. On a vérifié la validité de cette méthode au moyen des données fournies par des mesures.

LEWIS, C.P. and ASSOCIATES
Mackenzie Delta Sedimentary Environments and Processors: Issues and Recommendations, 17 p., 1987.

SUMMARY

The modern Mackenzie Delta is an active sediment surface which supports a large and vulnerable arctic/sub-arctic ecosystem that is very important to the traditional lifestyle and economy of the people of the region. The delta, including its ecosystem, has been created by and remains highly dependent on the Mackenzie River sediment that is disbursed through it by the distributary channel network. In addition, recent estimates suggest that the Mackenzie supplies about 96 percent of the sediment delivered annually to the Beaufort Sea. The nature of delta sedimentary environments, including the processes associated with them, therefore, will have major significance for engineering design on the delta surface. The danger exists, as well, that any development upstream from or on the delta plain that could affect sediment movement within or through the delta, could also significantly impact many other ecosystem components, both on the delta itself and throughout the bordering Beaufort Sea.

In spite of development pressures over the past 15 years, the data base relevant to all aspects of sediment movement and storage within the Mackenzie Delta remains largely inadequate for practical application. Several significant but limited studies were undertaken in the 1960's by Mackay (1963) and others (e.g. Gill, 1976; Smith, 1973) in the 1970's in association with proposals for a Mackenzie Valley gas pipeline and energy corridor. Since then, considerable work has been undertaken offshore but the only major onshore initiative has been the examination of distributary channel processes by Lapointe (1984). B.C. Hydro proposed an extensive investigation of "Mackenzie Delta Sedimentation" as part of its Liard River Hydroelectric Development studies but the project was cancelled while still in its initial stages.

The recommendations for future study which follow recognize the general limitations in our knowledge about sedimentary environments and the processes on the Mackenzie Delta but are intended to focus work on the topics of most immediate practical concern and to suggest approaches to those topics which will provide the greatest benefit for the least cost. The recommended studies are not presented in any order of priority. That will depend upon the individual perspectives of potential users and of the agencies that must fund the work.

LINTON, L.R., HAMILTON, H.R., and FUGLEM, M.
Similarities in Estimates of Suspended Sediment between Water Quality Branch and Water Resources Branch for Sites in the Saskatchewan River Basin, 69 p., 1988.

OBJECTIVES

Suspended-sediment data are collected by two Branches of Inland Waters Directorate, Environment Canada. The objectives of the work reported here were to evaluate the compatibility of the suspended sediment data (SS) of Water Resources Branch (WRB) with the nonfilterable-residue data (NFR) of the Water Quality Branch (WQB). The validity of pooling the data when necessary was assessed. The study worked with historical data collected from the Saskatchewan River Basin.

LUTHER, W.M.
"The Sediment Survey Laboratory", Water Ways, No. 11, p. 5-8, December 1966.

SUMMARY

This article explains in layman terms the sediment survey laboratories of the Water Resources Branch and the methods used. After samples are taken in the field they are shipped to the laboratories. In 1962 there were two laboratories servicing 50 sediment stations, with 2,722 samples analyzed. Two types of information are analyzed: sediment concentration; and particle size. Total sediment concentration by filtration, and particle size distribution by bottom withdrawal, pipette, sieving, hydrometer, and visual accumulation methods are described.

McILHINNEY, J.L.
Hydrographic Data Reduction and Analysis System Manual - HYDRA, 104 p., 1987.

BACKGROUND

What is HYDRA?

HYDRA stands for Hydrographic Data Reduction and Analysis system, developed for the Sediment Survey Section, Water Survey of Canada Division.

Its name implies its function, that is, to compute or reduce large volumes of hydrographic data collected from the field into a meaningful form from which pertinent analyses can be made.

HYDRA consists of a series of steps or stages in what is termed the HYDRA "process". These stages must be performed in a specific order. For example, the data which is obtained as the resultant from one stage, is the data to be input to the next stage.

For each stage of HYDRA, there are computer programs which perform the actual calculations on the data which is input. The HYDRA stages or 'PROCS' (from the word procedures) simply access which data to use, which program(s) to use on that data, and where to store the output data. Any errors detected by the computer in the data (or lack of data) will cause the program to "bomb", and an error message will appear on the computer printout to give an indication as to where the problem lies. Similarly, the PROC itself has built-in controls which ensure that the proper data has been inputted, inputted in the correct sequence, and stored or catalogued in its proper place for future use.

Throughout the process of HYDRA, a 377K memory computer, called the CYBER 730, is used. The computer is located at, and operated by, the Computer Science Centre (CSC), Department of Energy, Mines and Resources, Ottawa (613-996-0296).

McILHINNEY, J.L.
Station Review Plot Package, 55 p., 1988.

ABSTRACT

The following pages contain:

1) general information on acquiring plots and listings;
2) specific information you need to know about a station and selected plots before requesting plots;
3) a blank Plot Request form;
4) sample plots and listings.

Before requesting plots you should have an idea of the history of the station and which plots would be beneficial. Each plot costs between $2.00 and $10.00 while a total set of plots for one station would cost between $100.00 and $200.00 (before rebate, if applicable). Because of the costs for obtaining the plots, the amount of requests for plots and the limitations of our budget, it has been decided that small requests for plots will be handled through our Section, but larger requests should be done by your own Region. This can be done by filling out a form for an interactive account from Computer Services Center, E.M.R. Once this is complete and you have an account, you can run your own plot requests from your office using DATAPAC. Most of the plots can be requested by:

1) Enter "LOGIN,username,password." Press <RETURN> key.
2) Enter "ATTACH,X,PLOT,ID=PACKAGE1,PW=SSS,MR=1.". Press <RETURN> key.
3) Enter "IGET,A=START/X.". Press <RETURN> key.
4) Enter "BEGIN,START,A.". Press <RETURN> key.

Then follow the user friendly instructions to obtain the desired plots.

If you have any questions please call Joseph McIlhinney 819-997-1185.

McILHINNEY, J.L. and CASHMAN, M.A.
ODEN Curve Automation Study, 105 p., 1984.

INTRODUCTION

The bottom withdrawal tube analysis (BWTA) method is one of the standard methods used to analyze the particle size distribution of suspended sediment samples. This method is being used in the four Water Resource branch Sediment Laboratories in Canada and has been used in several Federal Sediment Laboratories in the United States for many years. The BWTA method of particle size analysis is based on the theory of a uniformly dispersed sedimentation system, which was first presented by Oden (1916). The method was later generalized by Fisher and Oden (1923), and summarized with discussions by Oden (1925) and Krubein and Pettijohn (1938).

Direct application of the theory for a given sample of sediment would require uniform particle size distribution, but this distribution in general is not available. Therefore, the graphical approach of the BWTA method is more generally adopted. The application of Oden's theory in the BWTA method results in an accumulation curve, the so-called Oden curve. This curve has time as the abscissa axis and percentage by weight of the total material settled out in a fixed column of 100 cm as the ordinate. A tangent is drawn from the Oden curve at a specific time, determined by a selected particle size at a given temperature, to intercept on the ordinate. This point of interception represents the corresponding "percent finer" of the selected particle. However. the range of time covering the settlement of the sediment is so large and the measured points are so unevenly distributed along the time scale that it is difficult to draw a continuous curve with an acceptable accuracy on rectangular coordinate paper. To overcome this difficulty, the curve is broken up into segments with overlapping between two adjacent segments (Report No. 7, The Inter-Agency Committee on Water, 1943). The average of two tangents is taken when a selected particle size is located in the end portions of two overlapping time segments.

The division of a continuous Oden curve into segments in some cases. has been found to cause discrepancies with the correct curve. For example, in the manual computations the larger scale makes it particularly difficult to accurately draw the right portions of curve C and curve D (Report No. 10, The Inter-Agency Committee on Water, 1953).

Automating the BWTA procedure would save a considerable amount of time over the manual computations and procedures. Also, it would provide better quality control as results would always be the same for a particular set of data. Due to human interpretation it is possible to get different results from the same set of data computed manually.

McLAUGHLIN, M.F.

Development of a Suspended Sediment Rating Curve Technique, 72 p., 1984.

SUMMARY

This report examines rating curve data requirements and controls, and presents a new suspended sediment rating curve technique. Rating curves from the simple linear least square fit to complex quadratic equations are discussed. A piecewise polynomial curve used to automate the interpolation of missing concentration data and the drawing of the hourly concentration curve is presented.

McLAUGHLIN, M.F.

A Review of Suspended Load and Bed Load Measurement Techniques (Field Studies), 35 p.

SUMMARY

This report reviews the various methods used in the collection of suspended sediment and bed load data. Point-integrating, depth-integrating, equal-transit-rate, and suspended and bed-load sampling methods are included. In most cases, existing techniques were created to satisfy specific requirements of a particular investigation, with the results that no single technique has yet evolved which can satisfy the requirements of all sampling conditions.

McLEAN, D.G.

Lover Fraser River Survey 1984: Agassiz-Rosedale Bridge to Mission, 38 p., 1985.

ABSTRACT

During the summer of 1984 hydrographic surveys were carried out overhead 46.5 km of the Lower Fraser River between Mission and the Agassiz-Rosedale Bridge. An Environment Canada crew with the automated HYDAC survey system collected over 400 cross sections along 38.5 km of main channel. UBC crews surveyed 136 cross sections over 10 km of the main channel and 18 km of side channels using conventional hydrographic surveying techniques. Approximately one man-year of effort went into the field work. This work represents the first comprehensive survey in this reach since 1952.

McLEAN, D.G. and CHURCH, M.
A Re-Examination of Sediment Transport Observations in the Lower Fraser River, 122 p., 1986.

INTRODUCTION

The main purpose of this report is to present estimates of the annual bedload and suspended load transport rates at Agassiz and Mission. As part of this study, a relatively complete review of the available sediment transport observations was carried out. Particular attention is given to predicting the size distribution of the load and to the problem of distinguishing the wash load and bed material load at each station. The reliability of the available measurements and the precision of the annual load estimates has also been assessed. Some aspects of this work have been published previously (McLean and Tassone, 1985; Mannerström and McLean, 1985).

The first sediment transport measurements on the Fraser River were collected by Johnston (1921) at New Westminster. Later on, a systematic programme of measurements was carried out between 1950 and 1952 at Hope (Kidd, 1953). These data were used by Mathews and Shepard (1962) to estimate the long-term sedimentation rate at the delta. In 1965 Water Survey of Canada began a comprehensive programme to measure the suspended load and bed load at several locations along the main stem and on some tributaries. Since this time bed load and suspended load have been measured periodically at Port Mann, Mission and Agassiz (Figure 1). Only suspended load data have been collected at Hope. Some early results from these measurements were analyzed by Tywoniuk (1972) and by Pretious (1972). More recently the data have been reviewed by Western Canada Hydraulics Laboratories Ltd. (1978) and an overview of the programme was prepared by Kellerhals (1984). However, for the most part, the data have received very little systematic or critical analysis.

McLEAN, D.G. and MANNERSTRÖM, M.C.
History of Channel Instability Lower Fraser River: Hope to Mission, 18 p., 1985.

ABSTRACT

The history of lateral channel instability along the lower Fraser River between Mission and Laidlaw is described. Channel changes over the last century have been documented by preparing a series of large scale channel shift maps. Some of the factors governing past channel instabilities are described. Vertical channel changes were studied by analyzing available data from hydrometric stations and from repeat channel surveys.

MEADE, R.H., YUZYK, T.R., and DAY, T.J.
"Movement and Storage of Sediment in Rivers of the United States and Canada", Surface Water Hydrology: The Geology of North America, Volume O-1, The Decade of North American Geology Project series, p. 255-280, 1990.

SUMMARY

This chapter covers how sediment is moved by rivers, the natural and anthropogenic factors that influence sediment yields, the storage of sediment in river systems at different time scales, the quantities of sediment transported by rivers of North America, and the principal sites on the continental edges at which river sediment is deposited. A comprehensive list of references is included.

MEADE, R.H., YUZYK, T.R., and DAY, T.J.
Sediment in Rivers of North America, 96 p. plus tables and figures.

SUMMARY

This is a chapter prepared for a DNAG volume on Surface Water Hydrology. It covers suspended and bed load, factors influencing sediment yield, routing and storage of sediment in river systems, and delivery of river sediment to coastal zones.

NORTHWEST HYDRAULIC CONSULTANTS LTD.
Assessment of Sediment Effects, Churchill River Diversion, Manitoba, Phase II Report, 39 p., 1988.

ABSTRACT

This report constitutes Phase II of a two-part study to assess sediment effects along the Churchill River Diversion and related waterways in northern Manitoba and to recommend further studies required for monitoring and assessment. The Phase I report, issued in May 1987 and revised in October 1987, discussed potential sediment effects, sources and sinks, and previously reported sediment budgets, and reported limited additional analysis of available sediment data.

The Phase II report considers additional technical information on the effects of uncontaminated sediment on aquatic resources and on the implications of contaminant attachment to sediment, and summarizes the indications of a limited examination of satellite images with regard to spatial and temporal variations in sediment content along the Churchill River Diversion. Cases for and against further sediment field studies are reviewed and recommendations are made for a limited program to satisfy in part the requirements of the Northern Flood Agreement and in part general scientific and national objectives. An assessment is made of sediment effects in relation to specific northern communities.

NORTHWEST HYDRAULIC CONSULTANTS LTD.
Assessment of Sediment Issues and Survey Program in the Prairie Provinces, 120 p., 1985.

INTRODUCTION

The study is one of a series commissioned in 1984 by the Sediment Survey Section of Water Resources Branch, Environment Canada. It was designed to provide a better understanding of the role and importance of streamborne sediment in the Prairie Provinces and to make recommendations for the future direction of the Sediment Survey program.

NORTHWEST HYDRAULIC CONSULTANTS LTD.
Sediment Station Analysis: Saskatchewan River at the Pas, 05KJ001, 250 p., 1986.

ABSTRACT

This is one in a series of sediment station analysis reports issued by Water Resources Branch, Environment Canada. It presents a summary and analysis of the 1954 to 1984 sediment record of the Saskatchewan River at The Pas. The data and analysis are interpreted in terms of upstream conditions and the changes that have occurred over the record period.

Hydroelectric, storage and irrigation developments in the basin during the record period have altered the flow regime and created sediment sinks. These developments include the construction of Gardiner Dam on the South Saskatchewan River and of Squaw Rapids Dam on the Saskatchewan River, both during the nineteen-sixties, as well as increasing irrigation withdrawals from the South Saskatchewan system. Prior to the Squaw Rapids development and creation of Tobin Lake Reservoir in 1963, the Saskatchewan Delta - Cumberland Lake complex was an area of net sediment deposition. It appears that since 1963 the situation has reversed and that the delta is now an area of net erosion.

It is considered that the available data at The Pas sufficiently describe the present sediment regime, and that the data collection program could well be suspended for a period and then reinstated to check for consistency. This recommendation should, however be discussed with Water Quality Branch. A short-term program is suggested to determine sediment loads in various parts of the delta complex in the Cumberland Lake area. Comments are also made about the Prince Albert station.

RÉSUMÉ

Aussi disponible en français.

NORTHWEST HYDRAULIC CONSULTANTS LTD.
The Use and Publication of Hydraulic and Morphologic Data for Canadian Rivers, 125 p., 1986.

ABSTRACT

The files of the several thousand Water Survey of Canada hydrometric stations in Canada contain hydraulic and morphologic information that is largely unprocessed for publication. An assessment of the potential value of making this information readily available in a published form was the primary purpose of the study summarized herein.

The long development of ideas on the systematic compilation of river data has principally been for scientific purposes. Adaption of these ideas to engineering and environmental studies is outlined. Several case histories are presented in which a Water Survey of Canada gauge was located in close proximity to sites where river hydraulic and morphologic data were collected for specific engineering studies.

A review is made of what baseline data are typically available at a gauge site, and what hydraulic and morphologic information could be extracted and published after perhaps some additional field work. Recommendations are made with respect to how alternative levels of publication effort could be pursued.

RÉSUMÉ

Les fichiers des milliers de stations hydrométriques de la Division des relevés hydrologiques du Canada contiennent des renseignements en matière d'hydraulique et de morphologie qui sont en grande partie non traités en vue d'une publication. L'étude résumée dans ce document avait principalement pour but d'évaluer dans quelle mesure il serait utile de faciliter l'accès à ces renseignements en les publiant.

La longue évolution des notions inhérentes à la compilation systématique des données relatives aux cours d'eau a surtout visé des buts scientifiques. On expose à grands traits l'adaptation de ces notions à des études de génie et à des études environnementales. On présente plusieurs cas de jauges de la Division des relevés hydrologiques du Canada situées à proximité d'emplacements où des données en matière d'hydraulique et de morphologie étaient collectées en vue d'études spécifiques de génie.

On examine quelles sont les données de base typiquement disponibles à un emplacement de jaugeage et quels renseignements en matière d'hydraulique et de morphologie pourraient être extraits et publiés après, peut-être, exécution de quelques travaux supplémentaires sur le terrain. On formule des recommandations sur la manière de mettre en branle d'autres formes d'activités reliées à la publication.

ONGLEY, E.D., YUZYK, T.R., and KRISHNAPPAN, B.G.
"Vertical and Lateral Distribution of Fine-Grained Particulates in Prairie and Cordilleran Rivers: Sampling Implications for Water Quality Programs", Water Resources, Vol. 24, No. 3, p. 303-312, 1990.

ABSTRACT

The fine sediment fraction, usually <63 μm, is generally regarded as significant for water quality issues. This fraction is usually presumed to be evenly distributed in the vertical column. Using period of record data for three prairie rivers and three cordilleran river sites, and midstream data from the Mackenzie River, we examine the degree to which near-surface samples of silt and clay are representative of the vertical and cross section. These data are available only for high flow conditions. Surface samples of silt + clay tend to underestimate the vertical means concentration by less than 10%; also 89% of the surface data at five of the six sampled sites are within ±15% of the vertical mean concentration. The individual vertical distributions of clay and silt display inconsistent and variable patterns of concentration with depth and can include large excursions within individual profiles. Our data do not indicate that large, deep rivers behave differently from shallow ones. There is no evidence of errors that may be expected if surface samples are used to characterize the water column at high discharges. A theoretical basis for the observations is provided together with a discussion of assumptions which render theory imprecise for fine-grained cohesive sediment.

PENNER, F., YUZYK, T.R., and OSHOWAY, R.
A Compilation of Manitoba Sediment Data to 1985, 200 p., 1987.

ABSTRACT

This report is a compilation of all the suspended sediment and bed material data that have been collected in Manitoba by the Manitoba Water Resources Branch and Water Survey of Canada. There is a total of 63 sites in the province where sediment data have been collected. The data are presented in various formats, with a possible nine figures and three tables used to depict the information for each site. Data collected by other agencies are also referenced. The information from this compilation will be used to help evaluate the sediment program in Manitoba.

POL, R.A.

Interpretation of Sediment Data, 1967-1985, Annapolis River Nova Scotia, 16 p., 1988.

ABSTRACT

Sediment data have been collected at the hydrometric gauging station site, Annapolis River at Wilmot, from 1967 to the present as part of the ongoing Water Resources Branch National Sediment Surveys Program. This report deals primarily with suspended sediment data collected during the period 1968 to 1985, inclusive, and presents the collected data in various tabular, graphical and statistical ways. It also contains a basin description and a section on land use and river sediments. The suspended sediment program, operated by the Water Survey of Canada Division, is evaluated and recommendations are presented. This material is intended for Federal/Provincial coordinators of water agreements, Water Survey of Canada staff and users of sediment data.

The analyses and interpretations of the sediment data are for the purpose of assessing if sufficient data exist for load determinations. The interpretation of the suspended sediment data set showed that our knowledge of mean characteristics of the sediment regime can improve only slightly; therefore, it is being recommended that the sediment station be discontinued and that the resources be reallocated to obtain sediment data in areas where monitoring has not been done.

RÉSUMÉ

Des données sédimentologiques ont été prélevées à la station de relevés hydrométriques de la rivière Annapolis à Wilmot à partir de 1967 jusqu'à présent. Ces prélèvements font partie du Programme national d'échantillonnage sédimentologique de la Direction des ressources en eau.

Ce rapport traite principalement de données sur les sédiments en suspension rassemblées durant la période de 1968 à 1985 et les présente sous formes de tableaux, de graphiques et de statistiques. Le rapport comprend aussi une description du bassin, une section sur l'utilisation du terrain, ainsi qu'une section sur les sédiments de rivière. Le rapport fait une évaluation du programme sur les sédiments en suspension de la Division des relevés hydrologiques du Canada et offre aussi des recommendations. Ce travail sera utile aux coordonateurs des ententes fédérales-provinciales sur l'eau, aux employés de la Division des relevés hydrologiques du Canada et aux usagers de données sédimentologiques.

Les analyses et les interprétations effectuées sur les données sédimentologiques ont permis d'évaluer la suffisance des données sur les sédiments en suspension pour en calculer le débit solide. Celles-ci ont montré que notre connaissance du régime sédimentologique en terme de production moyenne n'augmenterait pas sensiblement avec plus de données et qu'ainsi l'échantillonage peut être interrompu et les ressources réaffectées pour recueillir des données sédimentologiques dans des régions où l'échantillonage n'a pas encore été effectué.

POL, R.A.

Interpretation of Sediment Data, 1972-1985, Wilmot River Prince Edward Island, 16 p., 1988.

ABSTRACT

Sediment data have been collected at the hydrometric gauging station site, Wilmot River near Wilmot Valley, Prince Edward Island from 1972 to the present as part of the ongoing Water Resources Branch National Sediment Surveys Program. This report deals primarily with suspended sediment data collected during the period 1972 to 1985, inclusive, and presents the collected data in various tabular, graphical and statistical formats. It also contains a basin description and a section on land use and river sediments. The suspended sediment program, operated by the Water Survey of Canada Division, Water Resources Branch, is evaluated and recommendations are presented. This material is intended for the Federal/Provincial coordinators of the cost shared Water Quantity Surveys, Water Survey of Canada staff and users of sediment data.

The analyses and interpretations of the sediment data are for the purpose of assessing if sufficient data exist for load determinations. The interpretation of the suspended sediment data set showed that our knowledge of mean characteristics of the sediment regime can be improved only slightly by further sampling. The Wilmot River sediment station is one of two sediment stations in the most active agricultural zone of the province. The Wilmot gauge has more accurate sediment data relative to the other sediment gauge. Therefore, it is recommended that the detailed sediment sampling on the Wilmot River be continued for at least another five years.

RÉSUMÉ

Aussi disponible en français.

POL, R.A.

Interpretation of Sediment Data, 1966-1984, Kennebecasis River, New Brunswick, 40 p., 1987.

ABSTRACT

Sediment data have been collected at the hydrometric gauging station site, Kennebecasis River at Apohaqui, from 1966 to the present as part of the ongoing Water Resources Branch National Sediment Surveys Program. This report deals primarily with suspended sediment data collected during the period 1967 to 1984, inclusive, and presents the collected data in various tabular, graphical and statistical ways. It also contains a basin description and a section on land use and river sediments. The suspended sediment program, operated by the recommendations are presented. This material is intended for Federal/Provincial co-ordinators of water agreements, Water Survey of Canada staff and users of sediment data.

The analyses and interpretations of the sediment data are the purpose of assessing if sufficient data exist for load determinations. The interpretation of the suspended sediment data set showed that our knowledge of mean characteristics of the sediment regime can improve only slights; therefore, it is being recommended that the sediment station be discontinued.

RÉSUMÉ

Des données sédimentologiques ont été prélevées à la station de relevés hydrométriques de la rivière Kennebecasis à Apohaqui à partir de 1966 jusqu'à présent. Ces prélèvements font partie du Programme national d'échantillonnage sédimentologique de la Direction des ressources en eau.

Ce rapport traite principalement de données sur les sédiments en suspension collectionnées durant la période de 1967 à 1984 et les présente sous formes de tableaux, de graphiques et de statistique. Le rapport comprend aussi une description du basin, une section sur l'utilisation du terrain, ainsi qu'une section sur les sédiments de rivière. Le rapport fait une évaluation du programme sur les sédiments en suspension de la Division des relevés hydrologiques du Canada et offre aussi des recommendations. Ce travail sera utile aux coordonateurs des ententes fédérales-provinciales sur l'eau, aux employés de la Division des relevés hydrologiques du Canada et aux usagers de données sédimentologiques.

Les analyses et les interprétations effectuées sur les données sédimentologiques ont permis d'évaluer la suffisance des données sur les sédiments en suspension pour en calculer le débit solide. Celles-ci ont montré que notre connaissance du régime sédimentologiques en terme de production moyenne n'augmenterait pas sensiblement avec plus de données et qu'ainsi l'échantillonnage peut être discontinué.

SEDIMENT SURVEY SECTION

The Calibration and Testing of Southern Analyticals' A1690 Suspended Solids Recorder, 17 p., 1971. (prepared by Y. Durette)

SUMMARY

A suspended solids recorder, model A1690 of the Southern Analytical Ltd., has been in operation on the Fraser River at Port Mann for the past two years. The recorder consists of two separate pieces of equipment, these being an optical unit and an electronic unit, for measurement and display. A chart recorder was added to the unit for continuous recording of data.

This report assesses the reliability of the results obtained from the A1690 suspended solids recorder. This involved laboratory testing with samples of known concentration and testing in the field with subsequent analysis of the data obtained. The recorder was found to perform satisfactorily. Calibration curves were generated. A calibration curve for the high concentration range needed to be done.

SEDIMENT SURVEY SECTION

Effects of Diversion on the Morphology of the Athabasca-Peace-Mackenzie System, 38 p., 1971. (prepared by W. Stichling)

SUMMARY

This report makes a preliminary evaluation of the morphological effects of a proposed diversion of water from the Athabasca-Peace-Mackenzie watershed south to the Saskatchewan River basin. Constraints of a limited body of sediment data made it difficult to evaluate effects. The authors recommend the design and operation of a hydrometric and sediment network for the watershed, to include permanent long-term stations and stations established specifically for the proposed diversion project.

SEDIMENT SURVEY SECTION

General Field Procedures for the Collection of Individual Suspended Sediment Samples, 13 p., 1982. (prepared by Y. Durette)

SUMMARY

Instruction is provided on step-by-step field procedures for collecting individual suspended sediment samples at a single vertical. Definitions, depth-integrating samplers, site selection, sample collection, etc., are briefly outlined.

SEDIMENT SURVEY SECTION

Hydrometric and Sediment Survey Lower Fraser River Progress Report 1965-68, 133 p., 1970. (prepared by N. Tywoniuk)

ABSTRACT

The progress of the hydrometric and sediment survey of the Lower Fraser River, British Columbia, for the period 1965 to 1968 inclusive is described in this report.

Although hydrometric data for the Lower Fraser River have been collected since 1876, the sediment survey did not become fully operational until the spring of 1965. The sediment survey program was intended to provide streamflow, suspended sediment and bed load discharge and other related data for the Lower Fraser River region. These data are used in design, operation and maintenance of river channels and hydraulic works and facilities.

The operational aspects of the survey are outlined and described in detail. These include the equipment used, the field survey conditions and survey techniques, methods of analysis and interpretation of the data.

Preliminary results of the survey are illustrated by means of tables and graphs. Some of the pertinent data are similarly compiled in the appendices of the report.

Several conclusions with respect to the hydrometric and sediment surveys are presented. Finally, recommendations are made to continue with the present surveys for at least an additional ten years and to include in these surveys the delta region downstream from the Fraser River at Port Mann.

SEDIMENT SURVEY SECTION

Laboratory Tests on the Monitor Method of Filtration, 17 p., 1976.

SUMMARY

This study assesses the applicability of a monitor system of field filtration to determine sediment concentrations. The system described was developed to enable the filtration of suspended sediment samples, on site. The Swinnex 47 mm monitor marketed by Millipore Corporation was tested using the 3 micron membrane filter. It was found to be efficient and practical. The system is recommended for use by the District Offices for isolated sediment stations.

SEDIMENT SURVEY SECTION

Mira River 1976 Bathymetric Survey Results, 34 p., 1977. (prepared by K. Wiebe, Y. Durette)

SUMMARY

This report presents the methods used and the results obtained from a bathymetric survey conducted on the Mira River, Nova Scotia, from September 21 to October 1, 1976.

SEDIMENT SURVEY SECTION

Morphological Data Evaluation Saint John Watershed 1974, 51 p. plus appendices. (prepared by K. Wiebe, L. Drennan)

ABSTRACT

This report contains an evaluation of the morphological data collected in the Saint John Watershed located in New Brunswick, Quebec and Maine.

Data for this report were collected at one sediment station on the Saint John River and five sediment stations on its tributaries. Collection of data commenced as early as December, 1965 for the North Nashwaaksis stream to as late as April 1971 for Holmes Brook and Black Brook. Sampling on the Saint John River below Mactaquac was carried out from January, 1966 to May, 1968. To compliment the sediment data, a volumetric study in the lower reach of the main stream between Fredericton and Saint John was conducted in 1974.

All sediment stations are described in detail. Tables of sediment yield and figures depicting bed material particle sizes are located in the appendices. Particular attention is given to the watersheds of Holmes Brook and Black Brook as requested by the Canada Department of Agriculture Research Station in Fredericton.

The results of analysis in this report show that the sediment data available for the Saint John River Basin are too limited to allow a full morphological evaluation of the basin. Only general comparisons between sub-watersheds are attempted.

Recommendations are made to expand the sediment program through the implementation of sediment network study results. Further recommendations are made to reactivate the sediment station on the Saint John River below Mactaquac and to continue the volumetric study of the lower Saint John to assess the processes and rates of aggradation and degradation.

SEDIMENT SURVEY SECTION

Morphological Study Edwards Creek Watershed, 32 p. plus tables, figures, appendices, 1971. (prepared by K. Wiebe)

ABSTRACT

The morphology of the Edwards Creek watershed in Manitoba is evaluated in this report, emphasizing the settling basin, floodway and delta which formed at the mouth of the floodway.

Hydrometric data consist of flow discharges from March to October, 1957 to 1969 recorded at the hydrometric station near Dauphin. A sediment sampling program was initiated i 1969 and suspended sediment data collected at three sampling stations from March to October of that year. In addition, bed-material samples were obtained at selected sites on the drainage system of the watershed.

Volumetric data of sediment deposition and erosion in the settling basin, floodway and delta were obtained from topographic surveys conducted by the Prairie Farm Rehabilitation Administration in 1957, 1960, 1964 and 1968.

To evaluate long-term flow discharges and suspended sediment yields, the data for the former were reconstructed for the period 1913 to 1956 and for the latter from 1913 to 1968 through correlation and regression analyses. A tentative value for long-term bed-load discharge was obtained through the evaluation of bed-material particle-size distributions, volumes of eroded or deposited sediments and differences in suspended-sediment discharges at the three sediment sampling stations.

Detailed descriptions of all computational methods and survey techniques are given in the Appendices of this report. Results and all pertinent data are illustrated by means of tables and graphs. Finally, results are evaluated and recommendations made for decreasing the sediment discharge from the upper and lower Edwards Creek watersheds, increasing the sediment trapping efficiency of the settling basin and stabilizing the floodway channel.

The report recommends a continuation of the suspended sediment sampling program for several years, and the carrying out of topographical surveys of the settling basin, floodway and delta at periodic intervals.

SEDIMENT SURVEY SECTION
1973 Progress Report Bed Load Study Vedder River, B.C., 14 p. plus tables, figures, and appendices, 1974. (prepared by P. Zrymiak)

SUMMARY

This report presents a summary of data collected on the Vedder River, British Columbia, in 1973, describes the preliminary analysis and illustrates the results. The primary objective was the collection of bed load data on the six-mile section of the Vedder River extending from the Vedder Crossing bridge to the upstream end of the Vedder Canal. Continuous bed load data from this stream were required for the design of the dykes. This report is the second in a series of three similar data reports summarizing annual surveys, the first of which was conducted in 1971.

(see also Inland Waters Directorate, 1976, and Tywoniuk, N., 1972)

SEDIMENT SURVEY SECTION

Peace River near British Columbia-Alberta Boundary Proposal for a Sediment Station, 5 p., 1975.

SUMMARY

The Water Survey of Canada has investigated the possibility of establishing a hydrometric and sediment station near the British Columbia-Alberta boundary. The data collected would be of technical value to the Provincial hydro-electric companies for assessing the useful life-span of proposed reservoirs for hydro-electric development and of value to both Governments and the Provincial hydro-electric companies in the event of litigation.

The recommended location for the station is approximately 4 miles (6.44 km) downstream from the Clayhurst Ferry or 1.5 miles (2.42 km) east of the British Columbia-Alberta boundary. It would be necessary to utilize a catamaran style boat, similar to those used on the Fraser River to operate the station. This craft could be based at the Clayhurst Ferry.

Personnel to operate this station and approximately 20 hydrometric stations would be located at a new two-man sub-office to be established at Fort St. John. One man year and the work load from operating the 20 hydrometric stations would be transferred from Prince George to Fort St. John. One man year would be required for an additional technician's position and an additional 0.33 man year for casual help.

The estimated capital cost of the sediment station is $148,000. This includes the purchase of a fully equipped catamaran and a vehicle for the new technician. Annual operating costs including salaries have been estimated at $31,000.

SEDIMENT SURVEY SECTION

Progress Report Squamish River Estuary Morphological Survey, 29 p. plus appendices, 1976. (prepared by P. Zrymiak, Y. Durette)

PREFACE

In 1972, a Task Force, known as the "Squamish Task Force" was established within the Department of the Environment, Pacific Region, to study the effects of a proposed coal port development by the Pacific Great Eastern Railway near the town of Squamish. This development would occur around the Mamquam channel in the estuary. The concern on the part of the Department of the Environment was the effects such a development would have on the Squamish River estuary which has an active, growing delta of prime importance to the anadromous fisheries.

This report presents the methods used and the results obtained from morphological surveys conducted on the Squamish River estuary in November of 1973 and October of 1974.

SEDIMENT SURVEY SECTION
Sediment Investigations and Network Planning in Alberta, 15 p. plus appendices, 1978.

ABSTRACT

A sound knowledge of sediment transport and geomorphological processes in a watershed is essential in the planning and development of water use projects in that watershed, and an understanding of these processes depends in its turn upon the availability of an adequate body of observed sediment data.

Sedimentation and geomorphological problems in Alberta are not at present serious, but with growth in population and economic expansion and the increased demands on the province's water resources attendant upon this growth. it can be expected that problems with sediment transport and geomorphological processes will cause increasing concern. (A description of these processes appears in this report.)

This study looks at the potential areas of concern in Alberta, assesses these in terms of the type of investigation required, and assigns a recommended time frame to each. It is then a matter for the Government of Alberta, using this project list as a guide, to determine its own priorities within the framework of cost-sharing arrangements with the Government of Canada.

The vehicle for the study is an existing cooperative data-collection arrangement between the Water Resources Branch of Fisheries and Environment Canada and the Alberta Department of Environment.

SEDIMENT SURVEY SECTION

Squamish River Estuary Bathymetric Survey, 4 p., 1973. (prepared by K. Wiebe)

SUMMARY

The Squamish River, British Columbia, estuary survey was initiated to fulfill a provincial request for estuary sedimentation data to be used in the design of flood control projects. The surveyed area consisted on approximately a 3 mile reach of the Squamish River between its junction with the Mamquam River and Howe Sound.

Since the 1973 survey was the initial survey of the Squamish River estuary, sedimentation of the estuary could not be evaluated. However, the following recommendations could be made. First, subsequent surveys (at least one each year) should be scheduled to take advantage of high tidal cycles both on the monthly and daily basis to achieve the highest possible area coverage. Second, survey grid lines should have closer spacing than those achieved in the 1973 survey. A good spacing would be between 50 and 75 feet. Third, bed material samples should be obtained at random in each surveyed sector to determine the particle size distribution of the deposited sediment. Since suspended sediment data are available for the sampling station immediately below the Mamquam River junction, it would be possible, by comparison of particle size distributions, to calculate bed-load discharge into the estuary.

SMITH, B.D.

Sediment Data Analysis - Big Creek near Walsingham - 02GC007, 76 p., 1987.

ABSTRACT

Suspended sediment data were collected at the hydrometric gauging station site "Big Creek near Walsingham 02GC007" during the period 1966 to 1983 (station still active 1984-1986). This report documents data in various tabular, graphical and statistical forms. Descriptions of the reach, bed material data and photographs of the site are also included. Further intensive sampling will not improve the understanding of the suspended sediment transport at this site and it is recommended that the station be discontinued.

Results indicate that the sampling program operated within the entire range of flows and events and during a period of increasing annual mean flows. Seasonality trends in both discharge and sediment were evident and were partially precipitation oriented. Agricultural practices seem to agree with the seasonality of results. However, definite periods of flow-concentration relationships occur, examples being the spring versus summer months. No large scale changes in bed material or suspended sediment particle size occurs although bar migration occurs to the extent it controls hydraulic changes in the channel.

Database results in addition to summarizing sediment transport characteristics of this flow regime, were used for recommendations on the station's operational status.

RÉSUMÉ

Aussi disponible en français.

SMITH, B.D.
Sediment Surveys in the Ontario District, 16 p., 1976.

SUMMARY

This paper presents an outline of the sediment survey program in the Ontario District from its inception in 1965 to present day activities and make recommendations on new techniques and principles, expansion or discontinuation of stations and on analytical and daily methods involved in the Sediment Survey program.

SPITZER, M.O.
Sediment Data Milk River Basin, 29 p., 1987.

ABSTRACT

Sediment data were collected in the mid-seventies and the early eighties at seven gauging stations situated along the reach of the Milk River from above the western crossing of the International Boundary to immediately below its re-entry into the U.S.A. at its eastern crossing of the International Boundary. This report documents the available sediment information, presenting the data in various tabular and graphical formats.

In particular, for each gauging station, varying amounts of the following data are documented and discussed:

- descriptions of the gauging station sites (including air and ground photos)
- hydrometric details at the gauging stations sites
- suspended sediment data (concentration, load and particle size)
- bed material data
- dissolved solids data
- bed load data (only at the eastern crossing site)

The data are contained in individual appendices for each gauging station, while comparisons among the sites are contained within the main body of the report.

For the most part, sufficient data are available to make reasonable estimates of sediment loadings at various points along the Milk River reach, but these estimates must be based on procedures other than single line regression sediment discharge ratings.

RÉSUMÉ

Aussi disponible en français.

STICHLING, W.

"Instrumentation and Techniques in Sediment Surveying", in Proceedings of Hydrology Symposium No. 7 Instrumentation and Observation Techniques, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, p. 81-139, 1969.

SYNOPSIS

Total sediment discharge consists essentially of suspended sediment discharge and bed load discharge. Satisfactory instruments and techniques for measuring suspended sediment discharge have been developed over the last 25 years and the use of radio-isotope and other monitoring instruments promises to increase the effectiveness of existing methods. In the case of bed-load discharge measurement, however, equipment and techniques are still far from satisfactory. There is hope that research into the use of tracers or other techniques may lead to a break-through.

There are several analytical methods of computing sediment discharge. Some of these methods compute total sediment discharge; others compute bed-load discharge only. In either case, the grain-size distribution in the bed material must be known and information on other hydraulic parameters available. Satisfactory sampling of bed material is possible using existing equipment.

One of the important elements in a sediment survey program is a sediment laboratory equipped to determine (a) the suspended sediment concentration, (b) the particle-size distribution and (c) determination of density or deposited sediment.

This paper describes the equipment and techniques used for measuring suspended sediment discharge and bed-load discharge and for sampling bed material. Also described are the instrumentation and techniques used in a sediment laboratory.

STICHLING, W.

Sediment Loads in Canadian Rivers, 27 p., 1974.

also in Fluvial Processes and Sedimentation, Proceedings of Hydrology Symposium held at University of Alberta, Edmonton, May 8 and 9, 1973, by the National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, p. 38-72, 1973.

FOREWORD

This paper reviews the history of the sediment data collection program initiated in Canada in 1961, describes the latest equipment in use for measuring suspended sediment and bed load, and outlines the methods used by the Water Survey of Canada with those of other countries, and also compares sedimentation conditions and sediment yield.

STICHLING, W. and SMITH, T.F.
Sediment Surveys in Canada, 17 p., 1968.

ABSTRACT

The rapidly-accelerating pace of development of water resources in Canada leads to growing demands for more complete and more accurate information on hydrological and geomorphological processes in streams and watersheds. As time goes on, the availability of basic sediment data becomes more and more important in the planning and design of water development projects. To cater to the growing demands for sediment data, a comprehensive sediment survey program is vital; with emphasis particularly on alluvial regions of the country.

The sediment survey network in Canada is still in its infancy. The program has been under was for only a few years and as yet the number of stations for which data are available and the length of the period of observation are very limited. The next few years, however, will see a healthy expansion in the network itself and in the scope of the program generally.

This paper presents an outline of the Sediment Survey Program of the Water Survey of Canada, its current status including technical methods, instrumentation and data available, and a look at what is planned for the future of the program.

THOMPSON, M.P., JOE, H., and CHURCH, M.
Statistical Modelling of Sediment Concentration, 60 p., 1988.

ABSTRACT

Estimates derived from a "rating curve" may be used to replace costly daily samples of sediment concentration in assessing sediment discharge. This technique relies on the consistency of the relationship between sediment concentration and water discharge to estimate long-term sediment loads.

In this study, a regression/time-series approach to modelling the relationship between sediment concentration and water discharge is developed. The model consists of a linear regression of the logarithm of sediment concentration on the logarithm of water discharge plus an autoregressive time-series of order one or two for the errors of the regression equation. The model is used to estimate the annual sediment load and its standard error. Correction factors for the bias resulting from the inverse transformation of the logarithm of sediment concentration are studied. The accuracy of the load estimates is checked by comparing them with figures published by Water Survey of Canada.

RÉSUMÉ

Les estimations faites à partir d'une courbe de tarage peuvent servir à remplacer l'échantillonnage coûteux de la concentration des sédiments qui est effectué quotidiennement afin de déterminer le débit solide. Cette technique repose sur l'uniformité du rapport qui existe entre la concentration des sédiments et le débit de l'eau pour estimer le transport des sédiments à long terme.

Dans le cadre de cette étude, l'auteur utilise la régression et la série chronologique dans le but de créer un modèle illustrant la relation entre la concentration des sédiments et le débit de l'eau. Le modèle comporte une régression linéaire du logarithme de la concentration des sédiments sur celui du débit de l'eau et inclut également une série chronologique de premier ou de deuxième ordre à propriété d'autorégression pour tenir compte des erreurs dans l'équation de régression. Le modèle sert à calculer approximativement le transport annuel des sédiments et son écart type. L'auteur étudie des facteurs pour corriger l'erreur systématique provenant de la transformation inverse du logarithme de la concentration des sédiments. Puis, il vérifie la justesse des estimations du transport en les comparant avec les données publiées par les relevés hydrologiques du Canada.

TYWONIUK, N.

Background Interference Tests for WSC Hydrophone System, 13 p., 1971.

SUMMARY

The hydrophone systems was designed by Ithaco in 1971 in accordance with Water Survey of Canada specifications. The instrument, ITHACO Model 9120-78 Hydrophone System, is a wideband portable system for the acquisition, conditioning, and recording of underwater acoustical information. A series of tests were conducted to determine background interference due to velocity turbulence in the vicinity of the hydrophone weight.

TYWONIUK, N.
Processes of Sediment Transport in Rivers, 43 p., 1971.

SUMMARY

This paper describes the basic processes of sediment transport in an open channel flow system. Modes of transport, analysis procedures, transport theory, bed load transport theory and models, and total load transport are discussed.

A number of limitations or precautions must be observed in predicting suspended, bed and total loads of streams. In the case of prediction of suspended sediment load, the approach as developed by Einstein and Lane and Kalinski exhibits a number of shortcomings. The energy approach also exhibits serious shortcomings and as a result is not widely accepted. The problem arises in that the amount of energy required to transport sediment is a small percentage of the total energy expenditure of the stream which makes estimation of parameters in the energy equations subject to large errors. With respect to hydrodynamic modelling, the general limitations apply that are characteristic of all mathematical models. These include problems in development, verification and use. As with suspended load, the bed and total load equations also exhibit serious shortcomings. For all three, equations which incorporate a maximum of measured and sampled data (as the modified Einstein method) are likely to provide more reliable estimates than those which do not require field data. Similarly, simulation models should be verified with reliable field data if reliable results are required.

TYWONIUK, N.

Progress Report 1971 Bed Load Study Chillivack River, B.C., 12 p. plus figures and appendices, 1972.

SUMMARY

This report presents a summary of data collected on the Chillivack River, British Columbia, in 1971, describes the preliminary analysis and illustrates the results. The primary objective was the collection of bed load data on the six-mile section of the Vedder River extending from the Vedder Crossing bridge to the upstream end of the Vedder Canal. Continuous bed load data from this stream were required for the design of the dykes. This report is the first in a series of three similar data reports summarizing annual surveys.

(see also Inland Waters Directorate, 1976, and Sediment Survey Section, 1974)

TYVONIUK, N.
Sediment Budget of the Lower Fraser River (Estuary), 17 p., 1972.

also in Fluvial Processes and Sedimentation, Proceedings of Hydrology Symposium held at University of Alberta, Edmonton, May 8 and 9, 1973, by the National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, p. 624-638, 1973.

ABSTRACT

The Lower Fraser River, being continually developed for better navigation and larger port facilities, is an area of active sedimentation. The dynamic processes influenced by river discharge, tides and winds are probably the most important factors in the transport and deposition of sediments in the estuary. The main part of the Fraser Estuary is vertically homogeneous (non-stratified) and the sediments are transported progressively seaward and are accumulated near the limit of net landward flow. The lower estuary is stratified and coarse sediments are trapped near the toe of the salt wedge while the fine sediments are carried seaward with the outflowing river water.

The hydrometric and sediment survey of the lower Fraser River are described. Survey results are used in determining the sediment balance of the river reach. In the budget analysis, the river and estuary are divided into four consecutive reaches, the sediment discharges are subdivided to represent about 10 particle size ranges and the balance is then determined for each reach and particle size range.

Conclusions are drawn with respect to the sediment transport and depositional characteristics, annual variations, and the agreement between the sediment entering the estuary and the sediment dredged.

TYWONIUK, N.

"Sediment Discharge Computation Procedures", Journal of the Hydraulics Division, ASCE, vol. 98, no. HY3, Proc. Paper 8783, p. 521-540, 1972.

ABSTRACT

An analysis is made of some of the recent and more accepted sediment transport concepts as related to transport rates in flow systems. The analysis covers bed, suspended, and total load discharge computation procedures with descriptions of mathematical modelling techniques where applicable. The merits and limitations of the various procedures are described. Finally, recommendations are made with respect to the use and application of the analysis for sediment transport prediction.

TYWONIUK, N.

"The Sediment Survey Program", Water Ways, No. 9, p. 10-12, March 1966.

SUMMARY

This article outlines the objectives of the Sediment Survey Program, the types of special studies conducted, and standardization of equipment and techniques. The objectives of the Sediment Survey Program are:

1. Collection and publication of long-term basic sediment records on streams throughout Canada to provide data for: (a) design and operation of reservoirs; (b) design of canals, diversion works and drainage ditches; (c) prediction, evaluation and control of deposition in natural channels; (d) evaluation of erosion control measures; (e) design of treatment facilities for water supply; (f) improvement of fish habitat.
2. Determination of the relationship between sediment transport and various aspects of hydrology and geomorphology, particularly the relationship between erosion, sediment transport and deposition.
3. Extension of the survey to complement the hydrometric survey program in all parts of Canada and the standardization and improvement of equipment and techniques.

Special studies are conducted to determine the relationships between sediment transport and various aspects of hydrology and geomorphology, and can be manifested in monitoring of experimental basins, as an example.

Whether the data are to be used locally or internationally, it is equally important that the data be of acceptable quality or standard.

TYWONIUK, N. and CASHMAN, M.A.
"Sediment Distribution in River Cross-Sections", Fluvial Processes and Sedimentation, Proceedings of Hydrology Symposium held at University of Alberta, Edmonton, May 8 and 9, 1973, by the National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, p. 73-95, 1973.

SYNOPSIS

The variations in concentration and transport rate of a sediment-water mass in a river cross-section are the result of hydraulic variations in space and time. Moderately low and transversely uniform flow is generally characterized by low and transversely uniform sediment concentration. High and/or transversely irregular flows are similarly characterized by high and/or transversely irregular concentrations but with a different sediment-water ratio than for low flow. The dynamic processes which influence water transport in a river are also probably the most important influence on the distribution and transport of sediments in a river cross-section.

The variations in particle size distribution of sediments and in concentration and transport rate of a sediment-water mass in river cross-sections are illustrated herein. All available Canadian sediment survey data are used for this purpose. An assessment is made of the importance of spatial and time hydraulic variations as dispersing mechanisms under a wide range of natural flow conditions. Finally, theoretical expressions describing sediment-water transport phenomenon are verified and conclusions are drawn with respect to the applicability of these expressions to Canadian conditions.

TYWONIUK, N. and DRENNAN, L.
Progress Report 1972 Bed Load Study, Vedder River, B.C., 18 p. plus figures and appendices, 1973.

SUMMARY

This report summarizes the progress of the 1972 survey and the data collected, describes the preliminary analysis, and illustrates some of the analysis results. The objective of the survey was to obtain bed load data for a critical part of the Vedder River, British Columbia.

Field observations and survey results indicate that bed load discharge in the Vedder River is a function of not only flow (or mean velocity) but also of other factors, some of which are difficult to account for. These factors appear to become more pronounced as the flow increases as evidenced by the low correlation coefficient for the bed load discharge-flow relationship determined for the basket sampler measurements. The basket sampler is used mainly during very high flow periods for sampling of coarse gravel sizes (diameter greater than about one quarter of an inch). One of the factors influencing bode load discharges during high flow periods appeared to be the direction of change of stage with respect to time. The bed load discharge was found to be generally higher on the rising stage than on the falling stage. Also affecting bed load discharges during the 1972 field season was a backwater effect in the Vedder River caused by high Fraser River stages. This backwater effect reached upstream to the sampling cross-section influencing flow velocities and bed load discharges. A third factor influencing bed load discharges was a diurnal fluctuation in stage. This daily fluctuation usually resulted in a peak flow which occurred quite early in the dat and which often resulted in bed load being sampled on the recession stage.

TYWONIUK, N. and FOWLER, J.L.
"Winter Measurements of Suspended Sediments", WMO International Symposia on the Role of Snow and Ice in Hydrology Symposium on Measurement and Forecasting, 14 p.

ABSTRACT

Measurement of streamflow and suspended sediment discharge under winter conditions in Canadian Prairie watercourses is made difficult by substantial ice thicknesses, slush ice, freeze-up of equipment, hazardous conditions, and others. The measurement techniques, some of the difficulties as related to measurement during ice cover and methods of overcoming these difficulties are discussed.

The relative significance of winter flow and suspended sediment discharge are illustrated and alternative techniques of measurement of these parameters are outlined. The concept of measurement at a single vertical in a cross-section as compared to measurement at many verticals is described and conclusions are drawn with respect to the reliability of the winter measurement program.

RÉSUMÉ

L'épaisseur excessive des glaces, les glaces concassées, l'effet du gel sur les instruments et autres conditions hasardeuses rendent les relevés du débit des eaux et des sédiments en suspension extrêmement difficiles pendant l'hiver dans les cours d'eau des Prairie canadiennes. Les techniques de relevé, quelques unes des difficultés inhérentes aux relevés hivernaux et les méthods pour éliminer ces difficultés sont discutées dans cet exposé.

L'importance relative du débit des eaux et des sédiments en suspension pendant l'hiver est illustrée et différentes techniques pour la relevé de ces paramètres sont expliquées. Le concept de mesure à un point unique est décrit et certaines conclusions sont tirées en ce qui concerne la précision des relevés hivernaux.

TYWONIUK, N. and LUTHER, V.M.
Sedimentation Study of the Qu'Appelle Drainage Basin, 61 p. plus appendices, 1968.

ABSTRACT

Estimates of the total load discharge for eighteen Qu'Appelle River tributaries were made as follows:

1. the Modified Einstein Method, Meyer-Peter and Muller Method, and the Colby Method were used to estimate total load discharges for nine tributaries.
2. "Annual yield - area" and "maximum daily yield - area" correlations were obtained for the 1:2, 1:10, 1:25 and 1:50 flood hydrographs. Yield estimates for nine additional tributaries were made on the basis of the correlations.

A field survey was carried out in September 1968 to obtain bed and deposited material samples for nine tributaries and for the Qu'Appelle River and Valley. The laboratory analysis results are included.

The methods of analysis used in determining tributary sediment yields provide reasonable estimates for preliminary planning and design. A more detailed study is recommended for final design purposes.

TYWONIUK, N. and WARNOCK, R.G.
"Acoustic Detection of Bed-Load Transport", Fluvial Processes and Sedimentation, Proceedings of Hydrology Symposium held at University of Alberta, Edmonton, May 8 and 9, 1973, by the National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, p. 728-743, 1973.

SYNOPSIS

A hydrophone system developed to investigate the relationship between bed-load discharge and the intensity and frequency of the sound produced by inter-particle collision during sediment movement is described. A rating rank calibration for background noise levels illustrates the effect of water turbulence as related to water velocity for the audible spectrum. Finally, problems of filed measurement are described and 1972 data for the Vedder River near Yarrow, British Columbia, are shown. These data illustrate the cross-sectional noise levels at a study site, and the corresponding water velocities and bed-load discharge intensities.

WANG, D. and CASHMAN, M.A.

AUTOSANA: An Integrated PC Program Package of Sensitivity Analysis for Sediment Data Sampling Strategies User's Manual, 46 p., 1990.

SUMMARY

AUTOSANA is a network evaluation and planning program for sediment monitoring.

This manual provides operational guidelines for the software package developed by the Sediment Survey Section called AUTOSANA. AUTOSANA is an operational tool for the automation of sensitivity analysis against various sediment sampling strategies and data estimating procedures. It is an integrated and user-friendly PC program to verify and reorganize original data, establish sediment rating curves, estimate sediment data, and compare sediment estimates with published sediment data to evaluate the accuracy of the estimates.

The hardware requirements is a personal computer with an 8086 (80286/80386), 8087 (80287/80387) or math coprocessor, at least 512K RAM, a hard disk with at least 4MB free memory space, a graphic adaptor, printer, and plotter.

WASHBURN AND GILLIS ASSOCIATES LTD.
Freshwater Sediment Data Collection and Use in the Atlantic Provinces, 124 p., 1985.

EXECUTIVE SUMMARY

This report presents the findings of a study commissioned by the Water Resources Branch, Inland Waters Directorate of Environment Canada, into the collection and use of freshwater sediment data in the Atlantic Provinces. The primary objectives of the study were to acquire a better understanding of the key sediment issues in the Atlantic Provinces and to obtain a more complete recognition of the utility of Environment Canada's freshwater sediment data in addressing the present and future sediment issues of concern.

The study involved detailed discussions with a number of individuals in government, university, consulting and industry who were interested in freshwater sediment data. A standard questionnaire followed up the discussions with selected individuals. Information provided by these individuals was reviewed in detail, in order to identify the issues of concern in the region with respect to freshwater sediment. Recommendations for change to the Environment Canada sediment survey program were then developed in light of the issues of concern and the ability of the program to address those issues.

The existing Environment Canada sediment survey program in the Atlantic Provinces consists mainly of measurements and publication of suspended sediment concentration and loads at 17 hydrometric stations. There are six active stations in New Brunswick; four in Nova Scotia; three in Prince Edward Island; and four in Newfoundland (none of which are in Labrador). Since the sediment survey program was initiated, data have been collected from a number of stations with widely varying drainage basin sizes; some station data are short-term, while the longest period of record for any station is 20 years. The present database of sediment information does not appear to be targeted to any particular group of users in the Atlantic Provinces.

Various sectors throughout the working community of the region may have need for information on freshwater sediments. For the purposes of the present study, the key sectors adopted for categorization of users are government, university, consulting and industry. Although government involvement in freshwater sediment may include research and development of guidelines, governments in the Atlantic Provinces are also involved in regulations dealing with sediment. The federal Fisheries Act, and provincial water course alteration and environmental protection acts and regulations, may influence activities along rivers and streams and may thereby generate needs for sediment information.

Freshwater sediment issues in the Atlantic Provinces were identified through detailed discussions with a number of selected individuals. A list of potential contacts was first generated; then 106 persons were interviewed in detail and their responses recorded. Questionnaires were then sent to 102 persons, and completed questionnaires were returned by 88. The majority of the 106 contact persons (59%) were government employees. Within the government sector, 62% were affiliated with environment departments. An intermediate or high level of interest in the topic of freshwater sediments was expressed by almost all of the 106 persons.

A variety of interesting points were illustrated through the analyses of the results of personal discussions and questionnaire responses. With respect to the awareness and use of freshwater sediment data, it was found that:

- 70% were aware of Environment Canada program;
- 20% in the government sector were not aware of the program;
- about 33% had used the Environment Canada suspended sediment data at some time;
- about 60% need sediment data to evaluate upstream and downstream changes due to a particular activity;
- only seven percent indicated that they needed data for the design of engineering projects.

With respect to the collection and analysis of data, some of the key points found through discussions and questionnaire responses were that:

- the present distribution of suspended sediment stations in the Atlantic Provinces is inadequate, though the reason that it is considered so is variable depending upon the individual;
- there is interest in having other data to complement the suspended sediment data, such as upstream land use information, particle size distribution, chemical constituents, organic fraction, and dissolved load;
- many individuals require sediment information to evaluate erosion from the land;
- there is need for improved communication between government departments regarding the sediment survey program.

Once the freshwater sediment issues of greatest concern in the Atlantic Provinces were targeted, the objective was to identify the sediment processes associated with those issues and the corresponding data requirements. With data requirements known, the present Environment Canada sediment survey program could be evaluated against the data needs, and recommendations for change could be developed.

In order to quantify data requirements, the report provides a series of tables corresponding to nine key areas of activities or impacts in the Atlantic Provinces. Each table identifies potential problems; processes associated with the problems; and data requirements to evaluate the appropriate processes. The nine key areas discussed are fisheries, forestry, agriculture, mining, construction activities, water supply, hydropower, recreation, and applied research.

Based on the problems and associated data requirements which are particular to the Atlantic Provinces, it appears that the Environment Canada sediment data program, in its present form, provides a limited degree of support to data users. The primary reason is that many individuals require site-specific data for a limited period of time. Another important reason is that the transferability of sediment data (from one basin to another) is an open question to many data users. In addition, the Environment Canada data may be inadequate for those users who require additional data about sediment samples, such as organic fraction, metals content, or presence of contaminants.

It is noted, however, that despite the unknown "value" of the sediment data being collected at present, many individuals feel that sediment data are necessary for understanding the processes and the sediment regime of the region. This opinion was considered important, and it was reflected in the recommendations of the report.

The report provides a series of recommendations. Because the study had the objective of evaluating the Environment Canada sediment program from an outside perspective, the recommendations are broad-ranging, and do not necessarily follow the current program mandate. Recommendations are given in six sub-sections.

WASHBURN AND GILLIS ASSOCIATES LTD.
Proceedings of Freshwater Sediment Issues Workshop, June 26, 1986, Charlottetown, P.E.I., 69 p., 1986.

ABSTRACT

On June 26, 1986 a workshop on Freshwater Sediment Issues was held at the University of Prince Edward Island in Charlottetown. The workshop brought together individuals from the four Atlantic provinces who are dealing with problems of the source, transport, fate, and environmental effects of sediment in freshwater. Representatives from university, industry, consulting, provincial government, and the federal government took part in the intensive one-day workshop, which included 22 short presentations followed by four simultaneous working group sessions.

The workshop was jointly funded by the Environment Departments of the four Atlantic provinces and the Water Resources Branch of Environment Canada. The initiative of the Water Resources Branch was instrumental in making the workshop a reality.

The results of the workshop have been condensed into proceedings, which provide, first, the rationale for the workshop and its objectives; second, the proceedings themselves, given in a concise format; and third, a series of recommendations for new directions in sediment programs in the region. Recommendations are given which span the full range of sediment issues. The formation of a Regional Advisory Group is suggested for the coordination of research directions and data collection efforts.

WATER RESOURCES BRANCH

Delta Formation and Sedimentation in Lake Diefenbaker Annual Project Report 1972, 25 p. plus appendices. (prepared by K. Wiebe, P. Zrymiak)

SUMMARY

This report provides a detailed summary of survey work and data collected on Lake Diefenbaker, Saskatchewan, during the year 1972. The program was designated IHD Project Sask-2.

(see also Inland Waters Branch for earlier editions)

WATER RESOURCES BRANCH

An Initial Sedimentation Survey Programme for Canada, 22 p., 1958.

SUMMARY

This paper presents the need for sedimentation surveys in Canada, an outline of an initial program, and its approximate cost. General notes on several river basins are also presented.

Problems occasioned by sedimentation have not hitherto been of great concern in Canada, but they are becoming more numerous and more important with the increasing development of river systems for various purposes, particularly navigation, irrigation, flood control, power generation and industrial and domestic water supplies.

The establishment of 16 sediment stations is suggested. Stations would be located at or near discharge measurement stations. At each, depth-integrated samples of suspended sediment would be taken at regular intervals during the spring and summer. At important stations they may be taken daily or twice a week. At less important stations they would be done less frequently. The importance of sediment transport during flood conditions on sampling interval is recognized. The sediment program would be integrated as carefully as possible with the hydrometric survey operations to minimize duplication of effort. The estimated cost for the first year of operation is $50,000. It is anticipated that about one-half of the cost of operation, maintenance and analysis would be recoverable by the Department of Northern Affairs and National Resources under the policy determined for the conduct of the hydrometric survey program. Information on the Saskatchewan, Assiniboine, Milk, and Fraser Rivers is provided.

WATER RESOURCES BRANCH
Proposed Sediment Survey Lower Fraser River, 11 p. plus figures, 1964.

SUMMARY

In response to a request for the Department of Public Works concerning the feasibility of extending deep sea navigation up the Fraser River, British Columbia, to the vicinity of Mission, a proposed sediment survey to examine the possibility is outlined. Four cross-sections are recommended and outlined, those at Hope, near Agassiz, at Mission City, and near Port Mann. Equipment, installation, sampling, and cost requirements are outlined.

WATER RESOURCES BRANCH

Provisional Data for Lower Fraser River Sediment Survey 1969, 11 p., 1971. (prepared by K. Wiebe, P. Zrymiak)

SUMMARY

This report contains provisional sediment data for the Lower Fraser River and its tributaries between 1965 and 1969. Discharge, suspended sediment, bed load, and total sediment data are provided.

WATER RESOURCES BRANCH

Provisional Data for Lower Fraser River Sediment Survey 1970, 19 p., 1972. (prepared by P. Zrymiak)

SUMMARY

This report contains provisional sediment data for the Lower Fraser River and its tributaries between 1965 and 1970. Discharge, suspended sediment, bed load, and total sediment data are provided.

WATER RESOURCES BRANCH

Provisional Data for Lower Fraser River Sediment Survey 1972, 27 p.
(prepared by P. Zrymiak)

SUMMARY

This report contains provisional sediment data for the Lower Fraser River and its tributaries between 1965 and 1972. Discharge, suspended sediment, bed load, and total sediment data are provided.

WATER RESOURCES BRANCH
Provisional Data for Lower Fraser River Sediment Survey 1973, 26 p.
(prepared by P. Zrymiak)

SUMMARY

This report contains provisional sediment data for the Lower Fraser River and its tributaries between 1965 and 1973. Discharge, suspended sediment, bed load, and total sediment data are provided.

WATER RESOURCES BRANCH

Provisional Data for Lower Fraser River Sediment Survey 1974, 6 p. plus appendices. (prepared by P. Zrymiak)

SUMMARY

This report contains provisional 1974 sediment discharge data for the Lower Fraser River and the tributary station of Chilliwack River at Vedder Crossing. The samples collected at the six Fraser River stations and the tributary station of Chilliwack River at Vedder Crossing include suspended sediment, bed load and bed material. The 1974 sampling programs for the Fraser River stations were very similar to the programs of previous years.

WATER RESOURCES BRANCH

Provisional Data Report for the Lower Fraser River Sediment Survey 1975, 8 p. plus appendices. (prepared by P. Zrymiak)

SUMMARY

This report contains surface water data, provisional suspended sediment data and bed load data for 1975 for seven sediment stations on the Fraser River, British Columbia, and its tributaries. These stations are the Fraser River at Hansard (08KA004), Fraser River near Marguerite (08MC018), Fraser River at Hope (08MF005), Fraser River near Agassiz (08MF035), Fraser River at Mission (08MH024), Fraser River at Port Mann Pumping Station (08MH126). and the Chilliwack River at Vedder Crossing (08MH001).

WATER RESOURCES BRANCH

Sedimentation Study Belwood Reservoir (1971), 25 p. plus appendices, 1973. (prepared by L. Drennan)

ABSTRACT

The 1971 Sediment Survey of the Belwood Reservoir, Ontario, is described in this report.

This was the first of a series of at least three surveys which are to be conducted at this reservoir. Thirty-three cross-sections were established within the reservoir and their profiles were surveyed. Sampling of bed material and suspended sediment was also carried out during the survey. The survey results are illustrated by tables and graphs in the Appendices of the report.

Recommendations include a plan for subsequent surveys of the reservoir and an outline of methods to be utilized for determining densities of the deposited sediment. The computed density patterns and volumetric accumulation rates will form the basis for estimating sedimentation rates within all sections of the reservoir. This information should help pinpoint future problem areas thereby enabling preventive measures to be taken in some cases. Additionally the above sectional sedimentation rates will determine the overall reservoir sedimentation rate and therefore anticipated reservoir lifetime.

WATER RESOURCES BRANCH

Sediment Data Files Operations Manual, 105 p., 1977. (prepared by M.A. Cashman)

SUMMARY

The investigation of sediment transported by streams in Canada were first undertaken by individual organizations or agencies in 1947. However, it was not until 1961 that a systematic survey was undertaken by the Water Survey of Canada. Sediment data are now being published on an annual basis.

In 1973, it was decided to automate the publication of sediment data. This required the creation of additional files to what was already available for that purpose, i.e. FLOW and SUSCON (suspended sediment concentration) files. FLOW file has been operational since 1969 and SUSCON file since 1971. Four additional files were created, these are: SEDEX, PARTSIZE, TEMPERATURE and BEDLOAD, for a sediment station information inventory, particle size, temperature, and bedload data. The first automated sediment data publication was for 1971 data and it was distributed in 1974. Since then two additional publications have been introduced, the Sediment Data Reference Index and the Historical Sediment Data Summary Publication.

This manual outlines how to use the computer programs SUSCON, TEMPERATURE, BEDLOAD, FLOW, and PARTSIZE.

WATER RESOURCES BRANCH

A Study of Aggradation and Degradation of the South Saskatchewan River Gardiner Dam - Saskatoon - Annual Project Report 1971, 20 p. plus appendices. (prepared by K. Wiebe, P. Zrymiak)

SUMMARY

This report provides a detailed summary of sediment survey work undertaken on the South Saskatchewan River downstream from Gardiner Dam for the year 1971. It is a report prepared under the International Hydrological Decade (IHD), as IHD Project-1.

(see also Inland Waters Branch for earlier editions)

WATER RESOURCES BRANCH

A Study of Aggradation and Degradation of the South Saskatchewan River Gardiner Dam - Saskatoon - Annual Project Report 1972, 23 p. plus appendices. (prepared by P. Zrymiak)

SUMMARY

This report provides a detailed summary of sediment survey work undertaken on the South Saskatchewan River downstream from Gardiner Dam for the year 1972. It is a report prepared under the International Hydrological Decade (IHD), as IHD Project-1.

(see also Inland Waters Branch for earlier editions)

WATER SURVEY OF CANADA

Lower Fraser River Hydrometric and Sediment Survey Progress Report 1965-68, 165 p., 1970. (prepared by N. Tywoniuk)

ABSTRACT

The progress of the hydrometric and sediment survey of the Lower Fraser River for the period 1965 to 1968 inclusive is described in this report.

Although hydrometric data for the Lower Fraser River was collected since 1876, the sediment survey did not become fully operational until the spring of 1965. The sediment survey program was intended to provide water, suspended sediment and bed load discharge and other related data for the Lower Fraser River region. These data are used in design, operation and maintenance of river channels and hydraulic works and facilities.

The operational aspects of the survey are outlined and described in detail. These include the equipment used, the field survey conditions and survey techniques, methods of analysis and interpretation of the data, etc.

Preliminary results of the survey are illustrated by means of tables and graphs. Some of the pertinent data are similarly compiled in the appendices of the report.

Several conclusions with respect to the hydrometric and sediment surveys are presented. Finally, recommendations are made to continue with the present surveys for at least an additional ten years and to include in these surveys the delta region downstream from the Fraser River at Port Mann.

WATER SURVEY OF CANADA

Peace River near British Columbia-Alberta Boundary: Proposal for a Sediment Station, 6 p., 1975.

SUMMARY

The Water Survey of Canada has investigated the possibility of establishing a hydrometric and sediment station near the British Columbia-Alberta boundary. The data collected would be of technical value to the Provincial Hydro-electric companies for assessing the useful life-span of proposed reservoirs for hydro-electric development and of value to both Provincial Governments and the Provincial Hydro-electric companies in the event of litigation.

The recommended location for the station is approximately 4 miles (6.44 km) downstream from the Clayhurst Ferry or 1.5 miles (2.42 km) east of the British Columbia-Alberta boundary. It would be necessary to utilize a catamaran style boat, similar to those used on the Fraser River to operate the station. This craft could be based at the Clayhurst Ferry.

A review of technician time involved in operating the hydrometric stations in the area and the additional time required to operate the sediment station indicated that it would be most convenient to be based in Fort St. John.

Costs incurred operating out of Prince George of Peace River about balanced the costs of operating out of Fort St. John. One man year and the work load from operating the 20 hydrometric stations could be transferred from Prince George to Fort St. John. One may year would be required for an additional technician's position and an additional 0.33 man year for casual help. The estimated capital cost of the sediment station is $24,500. Annual operating costs including salaries have been estimated at $28,000.

WATER SURVEY OF CANADA

Proposal for Sediment Survey Lower Fraser River (Downstream from Port Mann), 24 p. plus appendices, 1971. (prepared by N. Tywoniuk)

SUMMARY

The purpose of this report is to illustrate the program and technical requirements for extending the Lower Fraser River, British Columbia, sediment survey to the delta downstream from Port Mann. The report was written in response to a request from the Department of Public Works for reliable information on the sediment load as related to continuing studies of maintenance and improvements to the navigation channel of the Fraser River. The proposal outlines the history or background to the requirements of hydrometric and sediment data, the details of the proposed survey extension, related surveys such as the use of isotope tracers and cost estimates.

WESTERN CANADA HYDRAULIC LABORATORIES LTD.
Analysis of Lower Fraser River Sediment Data for Water Survey of Canada, interim report, 44 p. plus appendices, 1977.

SUMMARY

Processing of Water Survey of Canada sediment and flow data taken on the Lower Fraser River, British Columbia, is completed, and bivariate relations are derived for sediment variables as a function of flow variables.

The bivariate data analysis is used to explore the overall quality of the data collected at each station for various flow conditions, and to determine what further data analysis is appropriate for the available data. Preliminary sediment rating equations are also provided for each of the sediment transport components, and the predictive value of measured, and derived hydraulic variables is evaluated.

An assessment is made of the techniques and sites used for the data collection, and recommendations for improvements in data collection procedures are suggested.

WIEBE, K.

A Description of the Hydac-100 System and its Application, 12 p.

SUMMARY

This report describes the Hydac-100 system in use by the Water Survey of Canada for small-reservoir sedimentation studies. The system is an automated data logger and was developed by Computing Devices of Canada Ltd. in cooperation with the Sediment Survey Section. The system consists of two sets of tellurometers, an echo sounder, a digital clock and interrogation control, an automatic event counter, a data coupler, an incremental digital tape recorder, and a digital printer. Generally, the survey procedure is to measure a baseline at the downstream end of the reservoir, select locations on one bank for the remote tellurometers and reference points, fix the locations through triangulation, and conduct soundings in the reservoir.

WIEBE, K.

Edwards Creek and Vermilion River Proposed Reservoirs: Estimation of Reservoir Sedimentation for a 100-Year Flood, 17 p., 1971.

SUMMARY

To circumvent the complexities of estimating sedimentation for a short duration flood the 100-year flood was converted to annual discharge with a return period of 100 years and applied to the proposed reservoirs of Edwards Creek and Vermilion River, Manitoba. Three methods were used to determine the annual discharge with a 100-year return period, these being a plot of observed annual discharges from 1948 to 1968 on log-normal probability paper, plotting annual discharges on Gumbel probability paper, and relating annual flows to peak discharge of the corresponding year in a regression analysis.

WIEBE, K.

Methods for Measurement of Sediment Accumulation in Reservoirs, 47 p., 1977.

SUMMARY

Depletion of storage capacity in a reservoir due to deposition of streamborne sediment generates many problems. In addition to storage loss, which as a high economic significance, there are operational problems, particularly for multi-use reservoirs. Correct information is required by resurveys not only on sediment accumulation including accumulation rates but also on its temporal and spatial distribution within the entire body of the reservoir. This report outlines and explains the methods used in the measurement of reservoir sediment accumulation. Methods for measurement of sedimentation in reservoirs fall into two broad categories, these being sediment transport and capacity survey. These two methods are outlined, as well as advantages and disadvantages, computation methods, capacity calculations, etc.

WIEBE, K. and DRENNAN, L.
Sedimentation in Reservoirs, 23 p. plus tables and figures, 197?

also in **Fluvial Processes and Sedimentation, Proceedings of Hydrology Symposium held at University of Alberta, Edmonton, May 8 and 9, 1973, by the National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, p. 538-579, 1973.**

SYNOPSIS

The construction of dams and impoundment of waters give rise to the problem of sedimentation. The magnitude of the problem depends mainly on the rate of sedimentation and can vary considerably.

A means to minimize the rate of reservoir sedimentation must be found to ensure that the water and power demands of a steadily increasing population will continue to be met. To obtain a satisfactory solution, the principal modes of sediment deposition in reservoirs and their relation to sediment supply, reservoir capacity and operating procedures must be understood.

This paper provides a detailed explanation of the above interrelated processes. Also included is an evaluation of sedimentation in Canadian reservoirs. Specific reference is made to Lake Diefenbaker with an outline of survey methods and a complete evaluation of the data obtained to data.

Finally, guidelines are proposed for consideration in the planning of future projects with potential problem areas being emphasized.

YUZYK, T.

Aspects Concerning Sedimentation of Avonlea Reservoir, 46 p. plus appendices, 1978.

ABSTRACT

Sediment filling of Avonlea reservoir, Saskatchewan, has been proceeding at a rate of 31.5 dam^3/yr. (25.5 acre-ft./yr) based on information obtained from the volumetric surveys completed in 1974 compared with those at construction. Under past flow conditions the reservoir will have a useful life expectancy in the order of 90 years.

The concern initially that the reservoir was losing storage capacity at a faster rate was due to the fact that the original reservoir capacity was incorrectly determined. Results from this study show that sedimentation rates for Avonlea reservoir are normal for its environmental ad drainage basin characteristics.

A review of equations and formulae designed to predict sediment yields for environments such as Avonlea showed them at variance with the value obtained from this study of 15.8 tonnes/km^2/yr.

YUZYK, T.R.

Bed Degradation of the South Saskatchewan River below Lake Diefenbaker, 65 p., 1987.

ABSTRACT

The creation of Lake Diefenbaker in Saskatchewan has resulted in significant changes in both the flow and the sediment regime of the South Saskatchewan River below Gardiner Dam. Bed changes are assessed using the cross-sectional and bed material data that were collected from the mid-1960s to 1985.

Degradation appears to be significant only at the ranges (R) nearest the Gardiner Dam. Based on minimum bed elevation, the largest change occurred at R-1-0 where 1.7 m was eroded between 1967 and 1985. Data relating to mean cross-sectional changes indicate the largest change, 0.67 m, for this period was at R-2.7. During the first ten years after closure of the dam changes occurred rapidly. In recent years, however, there has been a stabilization. This has been attributed to bed armouring, as indicated by the increase in median grain size (D_{50}) from 0.24 mm (1968) to 2.50 mm (1985) at R-1.0.

The flow model MOBED was found to overestimate the rate and extent of degradation. For R-1.0 and R-2.7, MOBED overestimated the rate between 1967 and 1985 by two and three times, respectively. The model over estimates because it does not take armouring into account. MOBED should be run again, this time using the newly developed sorting algorithm to see whether the model's predictive capability is improved.

It is also advocated that a much reduced survey, only covering from the dam to R-8.0, should be conducted in 1990; or directly following a release $\geq$1500 m^3/s. There is need to develop better bed material sampling methods to improve on the documentation of the armouring process. The role that large events play is not well understood from the existing data base and therefore this aspect warrants more work. The re-establishment of the Saskatoon station is important to provide further information on the sediment transport regime of the South Saskatchewan River.

YUZYK, T.R.

Bed Material Sampling in Gravel-Bed Streams, 62 p., 1986.

ABSTRACT

The characteristics of gravel beds are examined to provide insight into the complexities involved in sampling fluvial gravels. A review of the different hand sampling methods and bed material samplers is given to show their respective strengths and weaknesses. Criteria established by various organizations and individual researchers for collecting an adequate sample are assessed, the most rigorous criteria being incorporated in the guidelines. A sampling strategy is proposed with the understanding that further research is required.

RÉSUMÉ

Les caractéristiques des lits de gravier sont examinées pour mettre en lumière les aspects complexes de l'échantillonnage des graviers fluviaux. Un examen des diverses méthodes d'échantillonnage manuel et des échantillonneuses de matériaux de fond est présenté dans le but de démontrer leurs forces et faiblesses respectives. Sont évalués les critères établis par différents organismes et chercheurs indépendants pour assurer la collecte d'un échantillon approprié; les critères les plus rigoureux sont adoptés dans les lignes directrices. Une approche visant l'échantillonnage est proposée étant entendu qu'une recherche plus poussée est toujours nécessaire.

YUZYK, T.R.

Lake Diefenbaker, Saskatchewan: A Case Study of Reservoir Sedimentation, 135 p., 1983.

EXECUTIVE SUMMARY

In 1965 a field survey program was implemented to monitor general sedimentation patterns, delta formation and bank erosion in what was to become Lake Diefenbaker. The program consisted of establishing 38 range lines (cross sections), spaced so that they would be representative of changes and surveying them on a regular basis. A sampling program was included to collect information on suspended sediment, bed material and water temperatures. The field programs were conducted jointly by the Sediment Survey Section (Ottawa), Water Survey of Canada (Regina) of Environment Canada and the Hydrology Division, Saskatchewan Environment.

After fifteen years of data collection it was agreed that this program should be reviewed. The review focussed on two principal areas:

1. To compile, analyze and interpret all the data collected from Lake Diefenbaker and document the sedimentation patterns;

2. To evaluate the existing data collection program and identify changes required to ensure an effective and efficient program.

Sedimentation has not significantly affected the reservoir operation, since only 1.4% of the total reservoir capacity has been lost between 1966-1980. The area where sedimentation is significant is in the drawdown reach, which lost 19% of its volume, or a 1% loss in live storage. Bank erosion and slumping are active and estimated to have accounted for the other 0.5% of the total 1.5% loss in live storage. The dead storage was computed to have been reduced by 1.3% over this period.

Delta formation was determined to be affected by a low original bed slope, large water level drawdown and reduced sediment loadings in the latter years. The bed slopes indicate that the delta structure has yet to reach equilibrium.

Bed material sampling showed that deposited densities were considerably lower than empirically derived values, which greatly affected the deposited load estimates. Based on the sampling findings, a good agreement between station derived loads and the calculated deposited loads was obtained.

The following recommendations are made based on the findings of this report:

1. This joint program should continue, for it is providing a worthwhile contribution to understanding delta formation and reservoir sedimentation in the prairies. The information is proving to be not only of site specific importance, but transferable to other reservoir studies. It also provides the opportunity to train and to build upon the expertise already acquired in undertaking sedimentation studies.

2. Due to the low sedimentation rate, the survey interval should be

extended from three years to at least five years, the five year interval will insure continuity between surveys. Since most of the deposition is occurring upstream of the Saskatchewan Landing Bridge, and should likely be the case for quite some time, only those upstream ranges should be resurveyed in the future. Special area studies (Elbow, Swift Current Creek Delta) do not have to be resurveyed as they show negligible sedimentation.

3. Certain data collection methodologies (HYDAC-200 data, cross section vs. area method of surveying) need to be further evaluated and more comprehensive guidelines established for sampling (bed material, suspended sediment) in reservoirs.

4. Since the existing range data were not the most suitable data for evaluating the bank contribution; and since bank erosion and slumping are active, an alternative study using either terrestrial photogrammetry or concentrated cross-sectional work should be considered.

5. Numerical modelling of sediment deposition (such as HEC-6, MOBED) was not in the scope of this report, but it should be considered the next logical step. If undertaken prior to the next survey it may help further streamline the program.

YUZYK, T.R.

Proceedings of the Manitoba Sediment Issues Workshop: November 18-19, 1986, Winnipeg, Manitoba, 46 p., 1987.

ABSTRACT

It is becoming increasingly apparent that sediment is an important component in the evaluation of a broad range of environmental issues. In Manitoba, sediment data are used in the assessment of numerous water resources projects such as determining the life expectancy of a reservoir, identifying the effects of a diversion scheme or the designing of irrigation and drainage systems. Water quality studies are starting to focus on the role sediment plays in the sourcing, transfer, and fate of many pollutants. In fisheries, increased sediment concentrations impact negatively on the commercial and recreational fish populations in many areas of the province. Even in agriculture, sediment found in streams translates into lost productive soil from farm lands and into increased maintenance costs to irrigation systems.

The workshop brought together over fifty representatives from consulting firms, universities as well as from federal and provincial governments to identify sediment issues and to comment on the existing network of stations. The information obtained from this workshop is being applied by both the federal and provincial Water Resources Branches as part of an evaluation of the Sediment Program in Manitoba.

YUZYK, T.R.
Reservoir Sedimentation Studies in Canada, 35 p., 1984.

INTRODUCTION

This report was prepared for the following purposes:

- to review knowledge of reservoir sedimentation;
- to present methods to evaluate reservoir sedimentation;
- to compile and document findings from Canadian case studies;
- to make recommendations for further research and studies.

YUZYK, T.R.

A Review of the Various Sediment Discharge Formulae, 17 p., 1978.

SUMMARY

Bed load formulae can be sub-divided into three basic groups according to their theoretical relationships: bed load as a function of discharge; bed load as a function of tractive force; and bed load as it relates to relative roughness. At least one type of each are reviewed, these being the formulae of Schoklitsch (1943), Meyer-Peter and Muller (1948), Rottner (1959), Einstein (1950), and Toffaleti (1968). Most of the formulae are either empirical or semi-empirical in nature and have been based on the results of laboratory flume experiments. They should be considered only to provide estimates, if anything at all.

YUZYK, T.R. and CHAPIN, N.F.R.
Proceedings of the Alberta Sediment Issues Workshop September 27-28, 1988, Calgary, Alberta, 116 p., 1989.

ABSTRACT

It is apparent from the workshop that the problems relating to sediment are very diverse and in many cases a multidisciplinary approach is required to comprehend the magnitude of the problem. Numerous issues in Alberta relating to streamborne sediments were identified at the workshop. In the agricultural sector, erosion caused by water was found to be a significant problem and considerable research is being done to better understand the mechanics of the problem. At this eroded material enters the waterways, it affects the stream dynamics and channel morphology, which impacts on numerous engineering projects. This sediment may also be transporting contaminants which affect the water quality and the aquatic ecosystem. This consequently has detrimental effects on fisheries.

The workshop also focused on providing information on sediment-related programs delivered by key government agencies, showing how these agencies interact and providing insight into the future direction of these programs. Part of the workshop was spent on highlighting current initiatives of the Sediment Program which is cost-shared between Alberta Environment (River Engineering Branch) and Environment Canada (Water Resources Branch).

RÉSUMÉ

Il est évident, à la suite de l'atelier, que les problèmes reliés aux sédiments sont très diversifiés et, dans de nombreux cas, qu'une approche multi-disciplinaire s'avère nécessaire pour comprendre l'ampleur du problème. Un grand nombre de questions ont été identifiées au cours de l'atelier se rapportant aux sédiments fluviaux en Alberta. Dans le secteur agricole, l'érosion entraînée par l'eau constitue un problème considérable et il se fait beaucoup de recherche pour mieux comprendre les mécanismes de cette situation. Lorsque le matériel érodé s'introduit dans les débouchés, il influe sur la dynamique du cours d'eau et sur la morphologie du canal, ce qui entraîne des répercussions sur beaucoup de projets de génie. Ces sédiments peuvent aussi transporter des substances contaminantes qui ont une incidence sur la qualité de l'eau et l'écosystème aquatique. Les conséquences sont donc fâcheuses sur l'industrie des pêches.

Les participants à l'atelier se sont également attardés à offrir de l'information sur les programmes liés aux sédiments appliqués par des organismes gouvernementaux-clés, démontrant les interactions entre ces organismes et donnant une perspective de l'orientation future de ces programmes. Une partie de l'atelier a été consacrée aux points saillants des initiatives actuelles du programme sur les sédiments dont les coûts sont partagés entre la direction du génie hydraulique d'Environnement Alberta et Environnement Canada (Direction des ressources en eau).

YUZYK, T.R. and PENNER, F.

A Review of the Current (1988) Manitoba Sediment Program, 26 p., 1988.

BACKGROUND

In 1986, the Canada-Manitoba Hydrometric Coordinating Committee initiated a major review of the sediment network jointly operated by the provincial and federal Water Resources Branches. This review consisted of three distinct phases.

The first phase involved conducting a workshop to focus on the issues and data needs in the province. A multidisciplinary approach was taken in an attempt to broaden the scope of the existing program and to establish linkages among agencies needed to undertake integrated studies. The workshop was held in November, 1986, with the findings being documented in the workshop proceedings (Yuzyk, 1987).

For the second phase a major data compilation exercise was undertaken. This information was needed to help make sound technical decisions on the operation of the data collection programs at individual stations and to evaluate the network. The report (Penner, Yuzyk and Oshoway, 1987) was compiled and the data presented so that it would be useful to a broad range of users.

The third and final phase involved combining the information obtained from the first two phases and using it to make recommendations on the future and direction of the sediment program in Manitoba. This report completes this final phase.

ZRYMIAK, P.

Linking Sediment Computations to a 1-D Mathematical Model, 70 p., 1987.

SUMMARY

In the 1880's under the Public Works Act, Public Works Canada (PWC) assumed responsibility for the maintenance and improvement of the navigation channel in the Lower Fraser River. It has spent millions of dollars on dredging, training structures, and other forms of river maintenance in the lower 25 miles (40 km) to ensure safe operating conditions for vessels entering its ports. In recent times, PWC has requested sediment data from Environment Canada to facilitate the planning of dredging and maintenance operations.

In 1964, Water Survey of Canada (WSC) began supplying sediment data to PWC. WSC used the Cubature method to compute discharge data up to 1968 and then the Power Series method from 1969 to 1972, however, WSC stopped supplying these data when it was concluded that these routing techniques (used to produce water discharge data for sediment load computations) were not sufficiently accurate. Since then, WSC's primary objective at the Port Mann pumping station site on the Fraser has been to provide accurate water discharge data.

To achieve this objective, WSC obtained the assistance of the Water Planning and Management Branch (WPM), which had tested and applied a One-Dimensional (1-D) mathematical model to Canadian waterways. WSC asked them to apply the model using 1968 data (as it was the most intensively sampled year for sediment), to provide the discharge data, and to conduct a comparison with the Cubature method (published 1968 data). An account of their work is given by Bernard Morasse (WPM) in his report Generation of the 1968 Hydrometric Data of the Lower Fraser River, Using the 1-D Hydrodynamic Model. Morasse introduces a 1-D model which has been adapted specifically to the Lower Fraser River. He discusses routing methods and compares 1968 mean daily discharges produced by the cubature method to the 1968 discharges from the 1-D model.

This project's objective is to identify a method for producing reliable sediment loadings at the Port Mann site. This report discusses three procedures for computing sediment loads and presents 1968 loadings at Port Mann using these procedures. It compares the relative accuracy of the procedures and identifies the implications of applying the 1-D model.

The report concludes that the mean daily discharges from the 1-D model (using an hourly computation procedure) provides data that on an annual basis are 12% (range 10% to 26%) more accurate than mean daily discharges derived using the Cubature method.

The main recommendation of the report is to implement the hourly computation procedure for producing suspended sediment loadings, using discharges generated by the 1-D Model.

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ZRYMIAK, P.
1985 Goderich Harbour Survey Trip Report, 14 p., 1985.

SUMMARY

The purpose of this report is to provide an overview and results of the hydrographic survey done in 1985 in Goderich Harbour, Ontario. Three types of surveys were done. An area survey was done to collect hydrographic data in the estuary and harbour. Range line surveys were done to collect hydrographic data on five pre-determined range lines from the shore into the harbour. Bed material surveying was done to trace the movement of the shore sands and estuary deposits.

ZRYMIAK, P.

Sediment Survey Programs on the Fraser River, British Columbia, 47 p., 1982.

SUMMARY

Sedimentation in the Fraser River is a major concern to federal, provincial and regional governments because of its potential for creating serious problems. Unchecked sediment deposition in the Fraser River estuary could cause filling in of the navigation channel and flooding in the delta area. Before channel protection or other engineering works can be designed to prevent this, the mechanics of sedimentation must be understood. Therefore, in 1964, the Department of Public Works requested that the Water Resources Branch design and carry out sediment survey programs which would provide data for the study of the mechanics of sedimentation in the Fraser River.

This report contains a description of the programs and related data collection on the Fraser River. It was hoped that the results from the various programs would be useful for determining the volume and size of sediments transported into the navigation channel; computing water discharge under tidal conditions using a One-Dimensional Mathematical Model; determining if bed load transport could be computed by monitoring Dune (bed form) movement by means of hydrographic data; and in the Upper Fraser River, for providing information on effects of entrapment in reservoirs.

Attempts to measure the volume of sediment being transported to the Fraser River navigation channel have failed because of inability to compute sufficiently accurate water discharge data, and therefore bed load transport data, under tidal conditions. Calibration tests of the Mathematical Model produced water discharge figures in the Lower Fraser River to within the accuracies specified by WSC Laboratory tests indicated that computation of bed load transport from data obtained by monitoring dune (bed form) movement using hydrographic methods produces more accurate results than data obtained from using conventional bed load samplers and methods.

Recommendations for the Lower Fraser River stations include the conducting of a thorough analysis of Lower Fraser River data collected to 1981; the use of the sediment station review procedure to evaluate the data at all Fraser River sediment stations; the implementation of the One-Dimensional Mathematical Model to produce hourly water discharges at the stations on the Lower Fraser River; the integration of sediment computations into the Mathematical Model; the development of a technique for assessing the accuracy of the hydrographic method used for monitoring bed load transport; and finally to conduct a sediment station review on data collected on the Upper Fraser River.

ZRYMIAK, P. and CASHMAN, M.A.
Accuracy and Precision in Sediment Surveys: Annotated Bibliography,
77 p., 1986.

ABSTRACT

This report consists of a compilation of reference material on accuracy and precision relevant to suspended sediment. The reference material pertains to such subjects as sediment erosion processes, sedimentation in reservoirs, lakes and rivers, sediment transport, water quality and water discharge.

RÉSUMÉ

Ce rapport est un compilation de documents de référence concernant l'exactitude et la précision en matière de sédiments. Ces documents de référence traitent d'une variété de sujets dont les processus d'érosion, la sédimentation dans les réservoirs, les lacs et les rivières, le transport des sédiments, la qualité de l'eau et le débit.

ZRYMIAK, P. and DURETTE, Y.J.
An Investigation of the Morphological Processes occurring in the Squamish River Estuary, 15 p., 1979.

SYNOPSIS

In 1972, a long term morphological study of the Squamish River Estuary, British Columbia, was undertaken by the Department of the Environment as a joint project between the Sediment Survey Section of the Applied Hydrology Division, Ottawa, and the Water Survey of Canada, Pacific Region.

The objective of the study was to monitor the impact of water diversion and dredging on the Lower Squamish River Estuary.

The area under investigation consists of approximately a five kilometre stretch of the Lower Squamish River. The data necessary to determine estuarine sedimentation rates and distribution was collected through the use of the HYDAC-100 and reduced using the HYDRA computation system.

This paper presents the methods used and the results obtained from surveys conducted in 1973, 1974, and 1978. A direct comparison of the analyzed data provides the spatial and temporal distribution of sedimentation and delta formation within the estuary.

The variety of formats in which the results are available through the use of the HYDAC and HYDRA systems, as shown in this paper, greatly simplifies the task of evaluating estuarine regime alterations. This evaluation showed the upper portion of the surveyed reach to be stable. The central portion is undergoing significant changes on the northwest bank, while the face of the delta is advancing at a steady rate. This advance will probably extend across the mouth of the proposed harbour.

ZRYMIAK, P. and TASSONE, B.

Sediment Station Analysis Fraser River at Hansard 08KA004, 200 p., 1986.

SUMMARY

The Water Survey of Canada station, Fraser River at Hansard (08KA004), is located near the headquarters of the Fraser River. Hydrometric data is available from 1954 and sediment data is available from 1972.

Sediment sampling at this site was initiated to obtain data for the FRASER RIVER UPSTREAM STORAGE REVIEW REPORT (Fraser River Joint Advisory Board, 1976). The objective was a plan for flood protection and control in the upper Fraser River Basin. Data from this station were used in the Fraser River Upstream Storage Study's - "RIVER REGIME AND SEDIMENT STUDIES" (Varzeliotis, 1974) section of the report. This section discusses; possible upstream and downstream morphological effects resulting from dam construction and; sedimentation in the reservoir.

A preliminary study was completed and a report produced in 1974 on the effects of the proposed construction. The report concluded that the effect of river aggradation upstream of the reservoir would be negligible, however, downstream of the dam there would be significant changes. Recommendations stated that because of degradation downstream of the dam and sparsity of sediment data, there was a requirement to continue data collection at this station and at the Marguerite station. Another recommendation was to institute more sediment measuring stations on the Fraser River and its tributaries.

The purpose of this station is to review, interpret and present an analysis of the sediment and discharge data collected at Hansard. It contains station, reach and basin descriptions, a discussion on hydrology of the area, tables and summaries of the data collected, the equipment used and the collection procedures. It also contains an analysis and interpretation which deals with, record length, representativeness, sampling strategy, rating curves, particle size data, suspended sediment yield, sediment sources and dissolved solids.

The results of the analysis indicate:

1) the suspended sediment load transported annually can be quantified by (a) load transported seasonally or (b) water discharge data;
2) the strategy of intensive sediment sampling during high flows was effective for sediment load computations;
3) flows during the 12 years sediment sampling period are representative of the flows during 31 years of record;
4) flow data are independent, random and homogeneous for period of record;
5) no major changes in delivery of flow or sediment have occurred during their periods of record;
6) the bed load in the system is 2.5% of the total load; and,
7) the life expectancy for the proposed reservoir is 1250 years.

The main recommendation of this report is termination of the intensive sediment sampling program at this station. It also recommends:

1) A miscellaneous program to fill in data gaps;
2) A bed material sampling survey of upstream and downstream reaches; and
3) A clean up of the station file.

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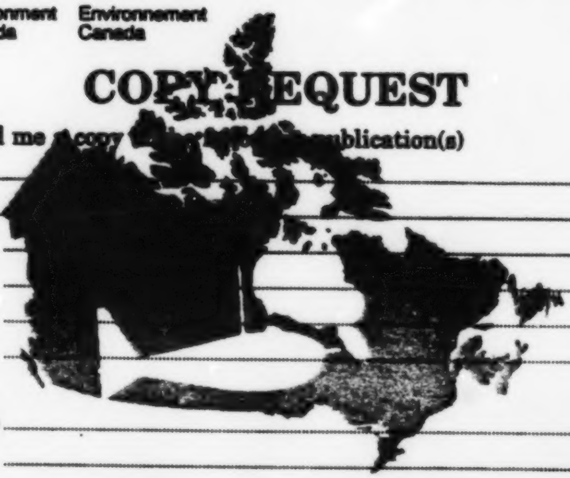

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